JOURNAL OF THE
SOCIETY OF
MOTION PICTURE
AND
TELEVISION
ENGINEERS

Evaluation of Image Sharpness

Three-Dimensional Films

Telecinema Audience Reaction

Optical-Magnetic Projector

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APRIL 1952

Society of Motion Picture and Television Engineers
JOURNAL VOL. 58 APRIL 1952 NO. 4

Subscription to nonmembers, $12.50 a year; to members, $6.25 a year, included in their annual membership dues; single copies, $1.50. Order from the Society's General Office. A 10% discount is allowed to accredited agencies on orders for subscriptions and single copies. Published monthly at Easton., Pa., by the Society of Motion Picture and Television Engineers, Inc. Publication Office, 20th & Northampton Sts., Easton, Pa. General and Editorial Office, 40 West 40th St., New York 18, N.Y. Entered as second-class matter January 15, 1930, at the Post Office at Easton, Pa., under the Act of March 3, 1879.

PRINTED BY MACK PRINTING COMPANY, EASTON, PA.

The Nature and Evaluation of the Sharpness of Photographic Images

By G. C. HIGGINS and L. A. JONES

The ability of a photographic material to produce pictures having good definition is commonly referred to as its sharpness, which is a subjective concept. The objective quantity $\langle G_x^2 \rangle_{Av} \cdot DS$ is shown to be a physical measurement which correlates with sharpness judgments. $\langle G_x^2 \rangle_{Av}$ is the mean of the square of the density gradients, $\Delta D/\Delta x$, across an abrupt boundary between a light and a dark area in the developed image and DS is the density difference between these areas. $\langle G_x^2 \rangle_{Av}$ is evaluated only for those values greater than 0.005 in density per micron which represents the threshold gradient. It is shown that, contrary to the generally accepted belief, resolving power does not correlate well with sharpness judgments and in some cases is even misleading.

An important property of a photographic material is its ability to produce pictures having good screen definition. This property of a material is commonly referred to as its sharpness. Sharpness defined in this manner is a subjective concept.

The obvious usefulness of an objective measurement which will predict the sharpness of pictures made on a photographic material led to an investigation of the nature of sharpness and the physical properties of the picture which are important in producing sharp images. During the course of an investigation by Jones and Higgins[1] on photographic graininess and granularity, the mode of functioning of the human visual mechanism was examined in some detail.

It is generally accepted that the magnitude of the neural response, which initiates the sensory or perceptual response which occurs when a cone in the eye is stimulated, is determined by the suddenness with which the stimulation changes. The cones, which are the receptors in the eye for photopic or daylight vision, therefore respond primarily to temporal illuminance gradients, $\Delta B/\Delta t$. When examining any object in a visual field, the eye is constantly moving, with the result that the cones repeatedly scan the image formed on the retina. The distribution of luminance in the object produces a

Communication No. 1459 from the Kodak Research Laboratories, a paper presented on October 15, 1951, at the Society's Convention at Hollywood, Calif., by G. C. Higgins and L. A. Jones, Eastman Kodak Company, Kodak Park Works, Rochester 4, N.Y.

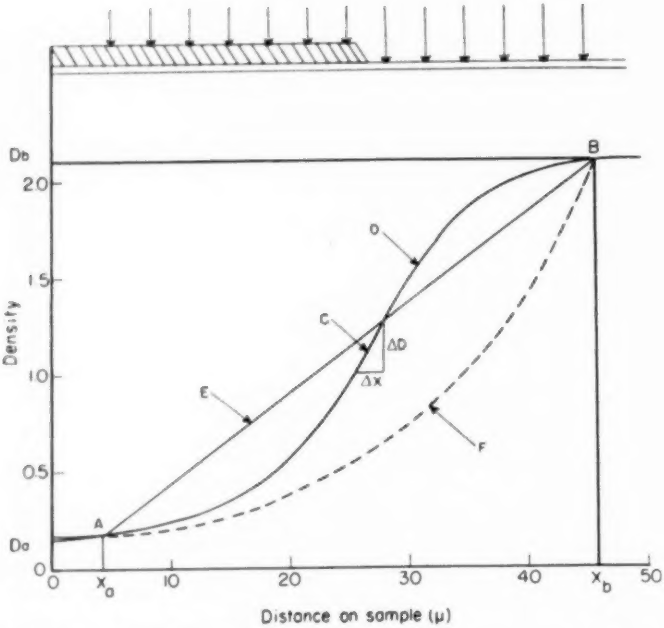


Fig. 1. Schematic diagram representing a knife-edge exposure and the microdensitometer trace, D, across the developed image. The straight line, E, between points A and B and the hypothetical dotted curve, F, represent traces having the same average gradient as curve D.

distribution of illuminance in the image formed by the lens of the eye. The motion of the eye then permits each of the cones to scan this illuminance distribution, the response of the cones being produced by the temporal illuminance gradients, $\Delta B/\Delta t$. This temporal luminance gradient consists of two components, the temporal component, $\Delta x/\Delta t$, produced by eye motion, and the spatial component, $\Delta B/\Delta x$, produced by the object being viewed, the product of the two components being $\Delta B/\Delta t$. The spatial luminance gradients, $\Delta B/\Delta x$, in the visual field therefore represent the physical aspects of the object which control the perception of detail.

The concept of gradient sensitivity has proved useful in finding an objective measure of a granularity which correlates with graininess. It appeared logical, therefore, to apply the gradient sensitivity principle to the problem of obtaining a physical measurement which will correlate with sharpness judgments of pictures.

When a photographic material is exposed while partially shielded by a knife-edge in contact with the emulsion, as shown schematically at the top of Fig. 1, the developed image does not end abruptly at the knife-edge but encroaches on the shielded area and has a diffuse boundary. A microdensitometer trace across a knife-edge image, made as shown schematically at the top of Fig. 1, is represented by curve D in the lower part of this figure. The ordinates represent density and the abscissas, distance on the sample in microns. When judging the

sharpness of this image, the cones of the eye move back and forth across this boundary in much the same manner as the fingers move back and forth across a piece of cloth when judging its roughness. The density gradients, $\Delta D/\Delta x$, across this boundary become log illuminance gradients, $\Delta \log B/\Delta x$, in the image formed on the retina. The motion of the eye converts these spatial log illuminance gradients into temporal log illuminance gradients which are the stimuli for the cones. The gradients are evaluated in terms of $\Delta D/\Delta x$ rather than $\Delta T/\Delta x$, since the response of the eye to luminance differences is known to be essentially logarithmic.

It has been suggested that the maximum value of the gradient, $\Delta D/\Delta x$, as shown at C, should be an indication of the sharpness of the image. However, experiments by Wolfe and Eisen[2] in these Laboratories have shown that the maximum gradient does not correlate with sharpness judgments. These same investigators have shown that the average gradient between any two points on this curve, such as A and B, also fails to correlate with sharpness judgments.

The average gradient, $\langle G_x\rangle_{Av}$, between A and B is independent of the density distribution between the points. Curve D, which represents a microdensitometer trace, the straight line, E, between A and B, and the hypothetical dotted curve, F, all give the same value of average gradient, $\langle G_x\rangle_{Av}$. If the physical aspect of the sample which determines the response of the cones is $\Delta D/\Delta x$, then the sharpness of the image should depend upon the rate at which the gradient changes across the edge. That is, the distribution of density across the edge represented by the three lines joining the points A and B should lead to three different sensations of sharpness. From the study of gradient sensitivity in connection with the investigation of graininess and granularity, it is known that the threshold gradient sensitivity in the photopic range is approximately 0.005 in density per micron. However, this threshold gradient, as indicated by the points A and B, is only an approximation and may have to be modified as more data are accumulated.

While there are numerous methods of evaluating the gradients in such a manner that the results will depend upon their distribution across the boundary, we have chosen to use the mean of their squares between the limits of 0.005 per micron. This average, $\langle G_x{}^2\rangle_{Av}$ is equal to $\int_A^B (dD/dx)^2 dx/(X_b - X_a)$. We chose to use $\langle G_x{}^2\rangle_{Av}$ since it is equal to the product of the average gradient measured at equal increments of D and the average gradient measured at equal increments of x; $\langle G_x{}^2\rangle_{Av} = \langle G\rangle_{Av(D)} \cdot \langle G\rangle_{Av(x)}$. It seems probable that in obtaining the average gradient, its evaluation should depend upon equal increments of D, since the problem involved is that of perceiving luminance differences and, for any given viewing condition, ΔD corresponds to a difference in log illuminance on the retina. This method of averaging has been found to yield fruitful results in obtaining a numerical specification of the contrast of printing papers, which is a somewhat similar problem.

On the basis of the knowledge of the mode of functioning of the eye, it seems probable that the subjective impression of sharpness should depend not only upon $\langle G_x{}^2\rangle_{Av}$, but also upon the density difference, DS, between the light and the dark areas. On the trace shown in Fig. 1, DS is equal to $D_b - D_a$. The objective quantity, $\langle G_x{}^2\rangle_{Av} \cdot DS$, was therefore investigated as a physical measurement which it seemed reasonable to expect to correlate with picture sharpness. We suggest that physical measurements based upon the density variation across a knife-edge image be termed "acutance." The formula $\langle G_x{}^2\rangle_{Av} \cdot DS$, therefore, gives values of acutance.

Wolfe and Eisen[2] prepared matched transparencies of the same scene printed on fine-grain positive film from ten different negative materials. The sharpest

Figure 2A

Fig. 2. The sharpest (B) and the least sharp (A) pictures made from negatives on ten different photographic materials.

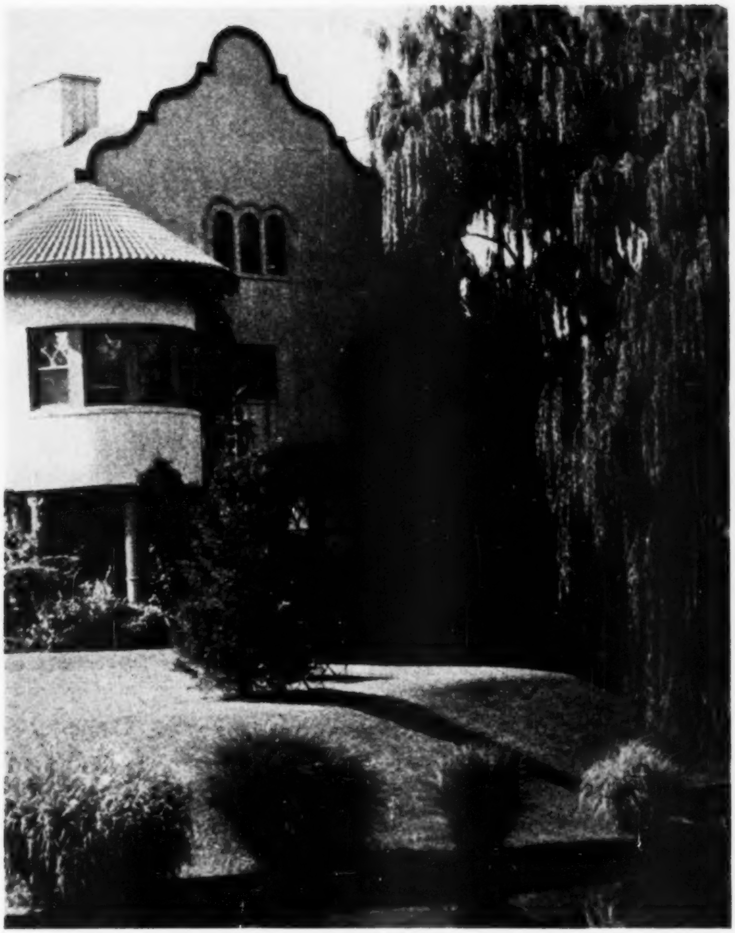


Figure 2B

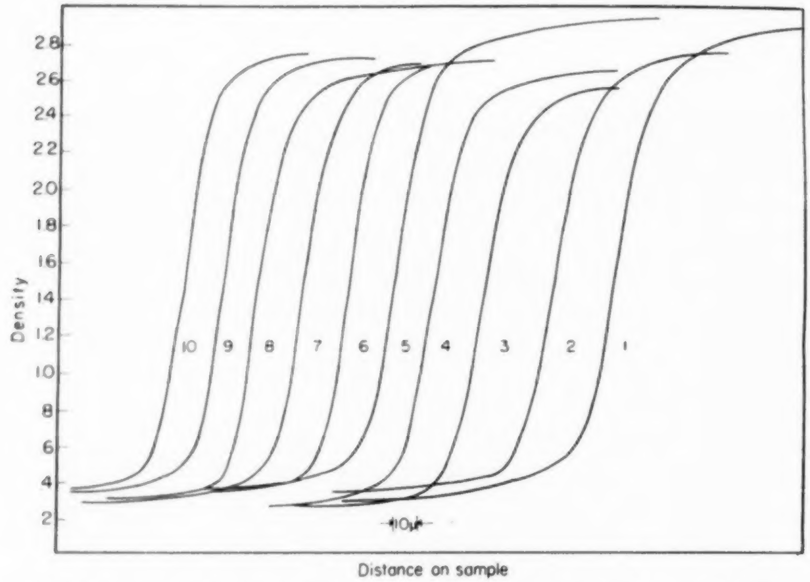


Fig. 3. Microdensitometer traces across the images in the positive as printed from knife-edge images on ten different negative materials.

picture, B, and the least sharp, A, made from these negatives are shown in Fig. 2. It is evident that the maximum difference in sharpness between the pictures made on these ten materials is relatively small. By subjective judgments of the relative sharpness of the positives from the ten negative materials, Wolfe and Eisen assigned numerical sharpness values to all positive transparencies. This method, which is an introspective psychological one, yields numbers of a purely ordinal nature which are not related to the objective character of the stimulus. The differences in sharpness in many instances were so small that different observers ranked a given pair of pictures in different orders, even though, based on the judgment of all observers, there was a real difference in sharpness between the two reproductions.

Knife-edge images were printed onto all negatives, and these images in the negative were, in turn, printed by contact onto fine-grain positive film. The microdensitometer traces across the knife-edge images in the positive are shown in Fig. 3. While the differences in the traces appear quite small, curve 10, which represents the trace on the sharper picture in Fig. 2, shows a higher slope and a more abrupt toe and shoulder than curve 1, which represents the trace on the least sharp picture shown in Fig. 2. As noted previously, the maximum slope of the curves does not correlate with sharpness. For example, curves 3 and 4 have essentially the same maximum slope, while all observers find pictures on material 4 sharper than on material 3. The significant difference between these two curves is the rounding-off of the shoulder and the slightly lower density scale on curve 3 as compared with curve 4.

The acutance values, $\langle G_x^2\rangle_{Av} \cdot DS$, were calculated for all traces and are plotted as a function of sharpness in Fig. 4.

The coefficient of correlation between the objective and the subjective measurements is 0.994. The relation shown in Fig. 4 is psychophysical, since it shows the correlation between a subjective (psychological value) and an objective (physical) factor. All materials are ranked in the same order and are spaced approximately the same on the sharpness scale. The very small difference in sharpness between prints from negative materials 1 and 10, as shown in Fig. 2, is represented by an acutance difference of 1620 or more than 100% of 1350, the value for the least sharp material.

For many years it has been the practice in the photographic field to report values of maximum resolving power for the different materials. Resolving power is usually measured by photographing a series of line gratings and determining the number of equal-width lines and spaces that are just resolvable when the developed image is examined visually under adequate magnification. While these measurements were intended specifically as a measure of the ability of the film to record fine detail, such as images of double stars or fine parallel lines, it has been generally assumed that these resolving-power values were a measure of the ability of the material to produce sharp pictures. However, experience has shown that resolving power as usually measured does not correlate well with sharpness judgments and in some cases may even be misleading.

The lack of correlation between resolving power and sharpness is strikingly shown by the prints in Fig. 5. The same negative was printed onto two experimental positive materials to give the best-matched tone reproduction possible. The positive material used in printing picture A has a maximum resolving power in excess of 230 lines per millimeter, while the positive material used in printing picture B has a maximum resolving power of 130 lines per millimeter. Even though the material used in making print B has a very much lower resolving power,

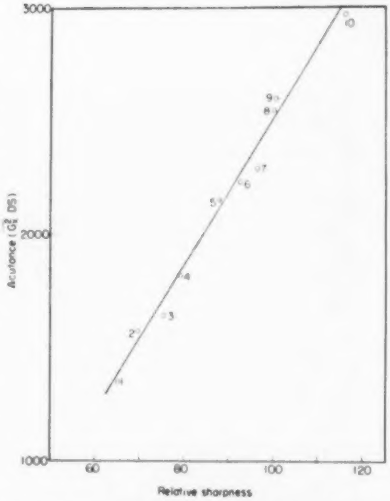


Fig. 4. Acutance, $\langle G_x^2 \rangle_{Av} \cdot GS$, plotted as a function of sharpness.

the picture is clearly much sharper than print A, obtained by printing on the high-resolving-power material. When making the pictures shown in Fig. 5, knife-edge images were printed onto the two positive materials. The microdensitometer traces across these knife-edge images are shown in Fig. 6. The difference between these two traces is readily apparent. Trace A, representing the less sharp material, has a very low slope and a long toe and shoulder, while trace B, representing the sharp material, has a relatively high slope and an abrupt toe and shoulder. The density scales are essentially the same for both materials. The value of $\langle G_x^2 \rangle_{Av} \cdot DS$ for the very sharp material is 12,210, while the value for the unsharp material is only 2,800.

The basic principle underlying the method of obtaining a physical measurement correlating with sharpness judgments of the photographic image should also apply to the evaluation of lenses where the luminance gradients of importance are those in the areal image formed

Figure 5A

Fig. 5. Prints from the same negative printed onto two experimental positive materials; material A having a maximum resolving power of 230 lines per millimeter and material B, a maximum resolving power of 130 lines per millimeter.

Figure 5B

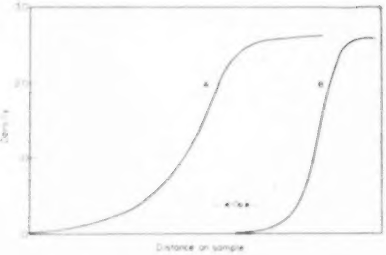


Fig. 6. Microdensitometer traces across knife-edge images printed onto the two positive materials used in making the pictures shown in Fig. 5.

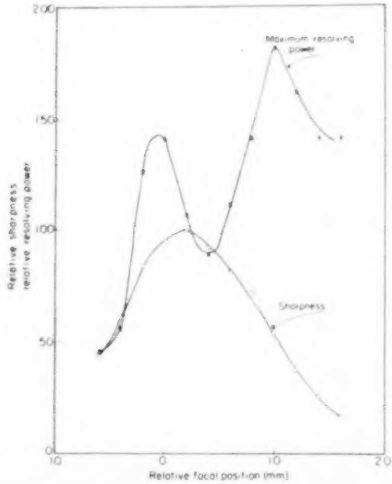
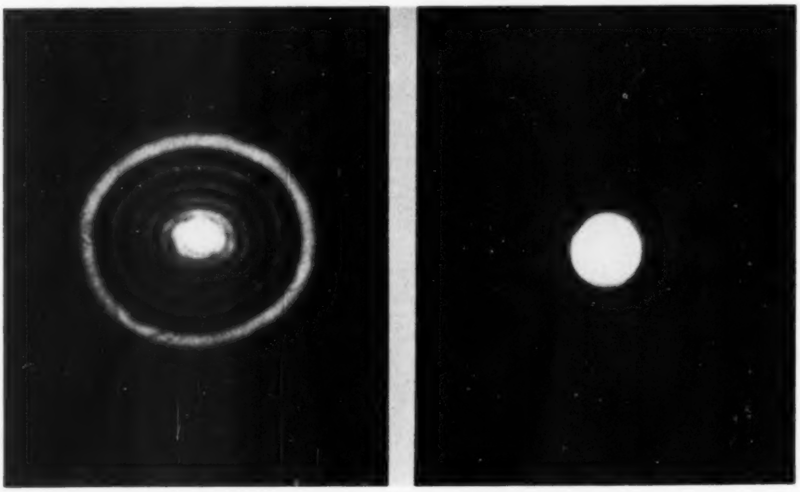


Fig. 7. Maximum resolving power and relative sharpness of pictures plotted as a function of the relative distance from lens to film when making the negatives.



A

B

Fig. 8. Photographic reproductions of the image of a point source as formed with a lens. B was made at the image distance giving maximum sharpness, and A was made at the image distance giving maximum resolving power.

by the lens. From the standpoint of photographic reproductions it is, of course, also necessary to examine the manner in which these luminance gradients in the areal image are reproduced as density gradients in the negative and in the positive. Wolfe and Eisen[3] examined a 12-in. lens designed for aerial photography by photographing the same picture repeatedly, the photographic material being placed at different distances from the lens. These negatives were then printed onto photographic paper and the resulting prints were judged for sharpness. A standard resolving-power test chart was also photographed under the same conditions employed in making the picture negatives. Maximum resolving power, as measured with a high-contrast test object, and relative picture sharpness are plotted as functions of image distance in Fig. 7. The abscissa values represent distance in millimeters from an arbitrary origin. As shown, the position of maximum resolving power is approximately 1 mm. from the position of maximum sharpness.

Wolfe and Eisen[3] also photographed a point source and a knife-edge under the same conditions that were employed in making the picture negatives. Photographic reproductions of the images of the point source are shown in Fig. 8. At the position of maximum sharpness, shown at B, the image of the point is fairly large but has very sharp edges, with practically no variation in density outside the central image, while at the position of maximum resolving power, shown at A, the image of the point is represented by a small dot surrounded by relatively large variations in density in the form of several light rings. Microdensitometer traces across the knife-edge images are shown in Figure 9. The trace made at the position of maximum sharpness, B, has a very high slope and a little toe or shoulder, while the trace made at the position of maximum resolving power, A, has a relatively low slope and a very pronounced toe and shoulder.

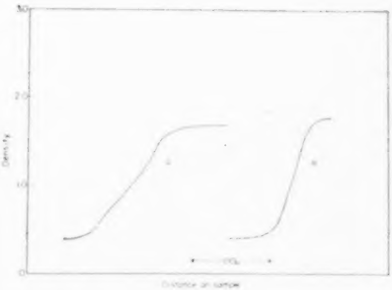


Fig. 9. Microdensitometer traces across photographic reproductions of the knife-edge image as formed with a lens. B was made at the image distance giving maximum sharpness, and A was made at the image distance giving maximum resolving power.

The values of $\langle G_x^2\rangle_{Av}\cdot DS$ as obtained from the traces representing maximum sharpness and maximum resolving power are 620 and 165, respectively. The acutance criterion indicates the focal positions giving maximum sharpness, while the criterion of maximum resolving power represents a focal distance 1 mm removed. The pictures shown in Fig. 10 were made with the film at the position of maximum sharpness, B, and at the position of maximum resolving power, A.

All data taken to date indicate that acutance measured as $\langle G_x^2\rangle_{Av}\cdot DS$ can be used to predict the sharpness of pictures made with different photographic materials. The data also indicate that this concept is useful in evaluating the sharpness characteristic of an image produced by a lens. However, the density difference, DS, across the knife-edge image is essentially the same for all samples investigated. The data, therefore, are not conclusive as to whether the DS term should be introduced, or if so, whether it should be introduced as a weighted function.

While it is shown that resolving power as usually measured cannot be used to

Figure 10A

Fig. 10. Photographic reproductions of the same scene made at the image distance giving maximum sharpness, B, and at the image distance giving maximum resolution, A.

Figure 10B

predict with certainty the ability of a photographic material or a lens to produce sharp pictures, it is nevertheless an important property of the materials. When viewed at 14 in. under optimum conditions, the eye can resolve a maximum of about ten black and white lines per millimeter. The resolving power of the film or lens must be sufficient to satisfy the limit set by the eye for a given viewing condition. We believe that, from the standpoint of sharpness, the important property of the image is the acutance of the edges of lines which are just resolved by the eye. Acutance measurements on lines of different widths and different frequencies, as well as different contrasts, should give this information. Resolving power is therefore a limiting condition which does not furnish information as to the sharpness of detail which is well resolved by the eye.

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1. Loyd A. Jones and George C. Higgins, "Photographic granularity and graininess: III. Some characteristics of the visual system of importance in the evaluation of graininess and granularity," *J. Opt. Soc. Am.*, *37*: 217–263, Apr. 1947.
2. R. N. Wolfe and F. C. Eisen, unpublished work.
3. R. N. Wolfe and F. C. Eisen, unpublished work.

Progress in Three-Dimensional Films at the Festival of Britain

By RAYMOND SPOTTISWOODE

The planning for the Telecinema is described, then the building and the projection equipment. Also discussed are the developing of stereoscopic cameras and new formulas, producing the films, and introducing stereophonic sound and large-screen live television shows. The success of various parts of the program is evaluated and possibilities for the future assessed.

THE FESTIVAL OF BRITAIN, 1951, was planned as a mid-century stock-taking of Britain's achievements in the arts and sciences, combined with an attempt to pierce into the future and foreshadow the developments of the next 50 years. The Great Exhibition of 1851 had stuck obstinately to the present; in fact it had dismissed electricity as a mere toy, and had treated the finding of oil as no more than a convenient replacement for candles. The planners of 1951 were determined not to be caught napping. Their centerpiece was an exhibition site on the South Bank of the Thames in London; and here, in a series of daringly executed buildings, they presented thematically the story of the people of Britain, their origin, their environment, their way of life, their discoveries.

From the very beginning, the motion picture had its place in this thematic treatment. Despite periodic ups and downs, British studios have made notable contributions to the art of the film, and these were commemorated in 1951 by a cooperative production, *The Magic Box*, which told the story of William Friese-Greene, one of the pioneers who aided in the invention of the movie camera.

The Festival authorities provided on the South Bank a new building, the Telecinema, and a new program in which, for the first time in the world, live big-screen television and three-dimensional films were to be combined on an equal footing as an entertainment foreshadowing the movies of the future.

Glancing ahead for a moment, it may be recorded that the Telecinema and its program was one of the outstanding successes of the Festival. With only

Presented on October 19, 1951, at the Society's Convention at Hollywood, Calif., by David R. Brower, Assistant to the Manager, University of California Press, Berkeley, Calif., for the author, Raymond Spottiswoode, Kingsgate, Sudbury Hill, Harrow-on-the-Hill, England, who was Technical Director, Stereofilm Program, Festival of Britain, 1951.

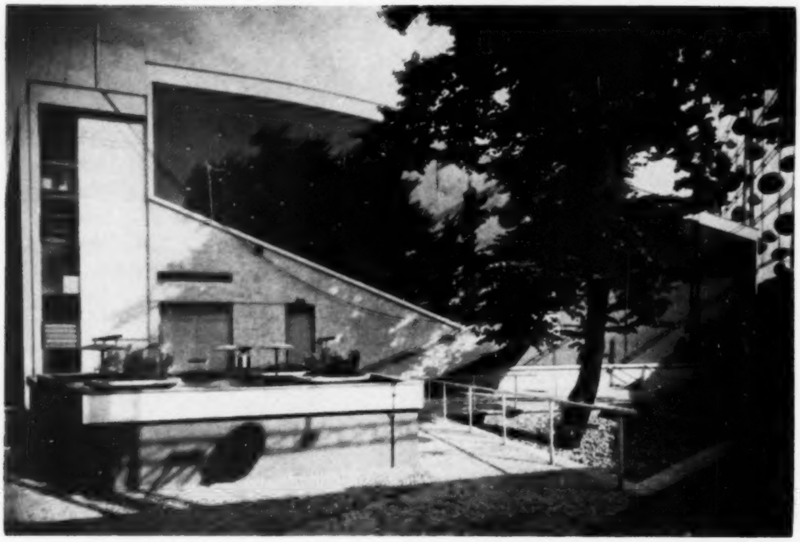


Fig. 1. The Telecinema building.

400 seats, it grossed in five months about $225,000, converted at the old rate of exchange normally used for economic comparisons. The total audience was very nearly half a million; but this could have been greatly increased, if the Festival had not had commitments to include in the program a number of documentary films which had been specially produced for it. As it was, with seven to nine shows a day, the public had to queue for between one and three hours to get in — a period often very much longer than that of the program itself. Yet throughout the 22 weeks, there was not a single complaint, and many people returned to the Telecinema again and again.

In the short space of this paper, I shall try to describe the Telecinema building and the events which led up to the completion of the 33-min series of stereoscopic and stereophonic films. If I say little about television — for which 1,220 live shows were produced — it is only for lack of space; it played a vital part in the construction of our programs.

The Building

Work on the Telecinema was started late in 1949. The Festival was extremely fortunate in its choice of architect. Wells Coates, though hampered by a narrow site pressed close against a railroad bridge, succeeded in producing a building of elegant and simple lines, with a seating capacity of 400 and adequate space for the many supplementary services required (Fig. 1). The inside of the theater (Figs. 2 and 3) is austerely simple, but it is saved from any feeling of severity by its attractive color scheme of varying shades of blue. The Festival motif was introduced in a Venetian-blind curtain of original design. The building was laid out exclusively for use with modern safety-base film, thus allowing certain precautionary measures to be dispensed with, and permitting a type of construction (sometimes from its shape called "lobster-

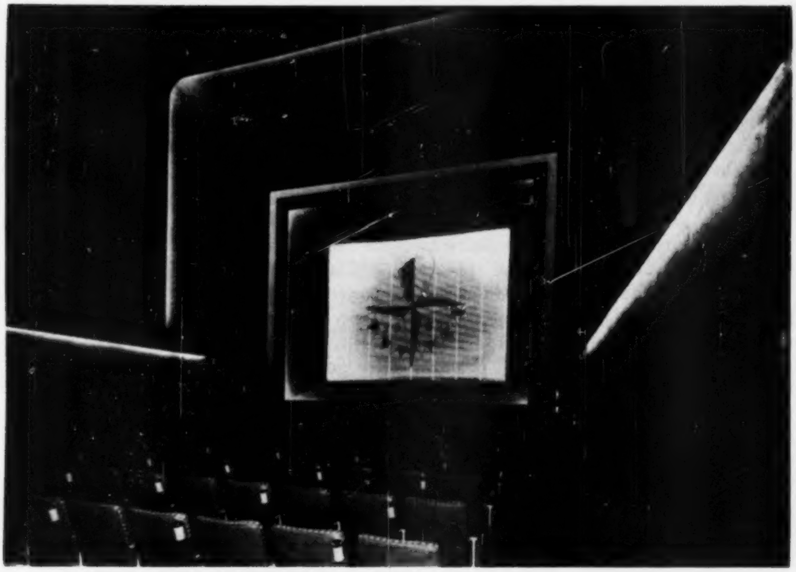


Fig. 2. Interior of the Telecinema — view from the stalls.

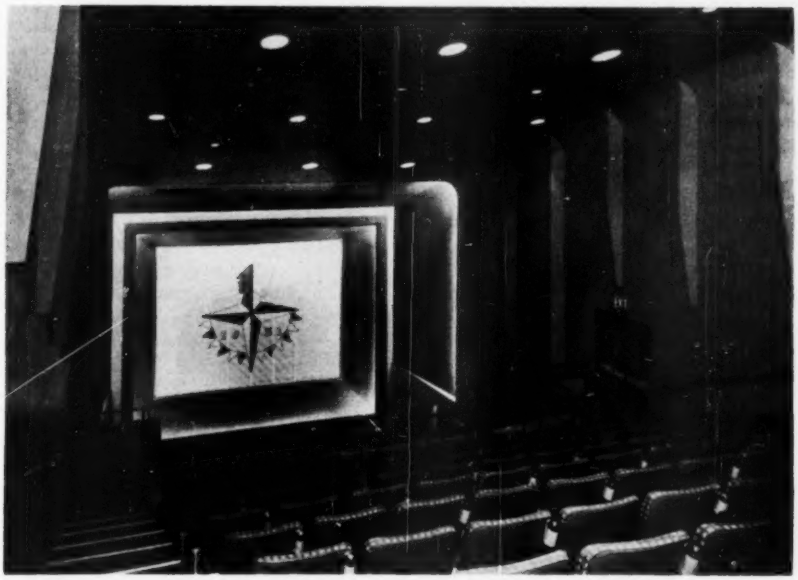


Fig. 3. Interior of the Telecinema — view from the circle.

claw") in which the projection room is enclosed in the space between the upper and the lower tiers of seats (see Fig. 4). This gives a horizontal projection beam, with a picture free from keystone distortion, and also provides a platform within 45 ft of the screen for mounting out of sight the Schmidt-type television projection equipment. In the Telecinema, this projector (built by Cinema-Television, Ltd.) was placed centrally, and was swung out of the way for film projection by means of a turntable and rails. This structural arrangement necessitates a rather high position for the screen, and the front seats in the theater are accordingly given a reversed slope. The Stableford screen was of the high-gain, non-depolarizing type, equally suitable for television, three-dimensional and flat films, and, in spite of the metallic surface, a remarkably wide light distribution is secured by special design. Uniform screen brightness from the side front seats is aided by giving the screen a slight cylindrical curvature of a radius equal to the projector throw. Though the screen itself has a width of 20 ft, the image width is only 15 ft, the remaining area forming a band around the picture which receives a diffused light picked up from the film itself and projected onto the screen by a device produced by the British Thomson-Houston Co.

Figure 5 shows the disposition of some of the equipment in the projection-room, as viewed through the large glass window which enables the audience when entering the theater to see "what makes the wheels go round." The television equipment consists of a camera and control console (not shown) which feed a video signal to the console on the extreme left, from which the signal passes to the projector placed immediately in front of the front wall of the projection room. The film projectors are BTH S/U/P/A machines synchronized by selsyn interlock, and behind them stand two BTH-HMV 4-track magnetic recorder-reproducers for handling the stereophonic sound tracks. Non-sync magnetic machines and complex switchgear complete the projection room installation.

This is the equipment which rendered such satisfactory service throughout the Festival in 1951. But in the early part of 1950 no equipment of any kind was available in England for producing or projecting stereoscopic and stereophonic films. All of it had to be designed and built, and the films produced, in only 14 months. First to be put in hand was the magnetic recording and re-recording equipment. In order to reduce inter-track magnetic interference, it was decided to employ no more than four sound tracks, the wide dynamic range making a control track unnecessary. Three of these tracks were to feed three banks of loudspeakers placed symmetrically across the screen (Fig. 6), the outer ones being set as far apart as possible to widen the sound base. Thus only a single track remained for feeding the groups of loudspeakers mounted and wired in parallel behind the balcony and stalls, and (again in parallel) in the main ceiling and in the ceiling of the rear stalls.

In the writer's opinion, the use of three channels behind the screen has not been adequately justified, the Philips company in Holland having given extremely convincing demonstrations of back-of-screen stereophonic sound, employing only two channels, the center loudspeaker being fed with low-frequency nondirectional sound from a bridge circuit.

Shortly afterwards, construction work was started on a stereoscopic camera based on two Newman-Sinclair units facing inwards in conventional fashion toward a pair of mirrors, and so mounted that the inter-lens separation (stereo-base) could be varied from 1 to 8 in., and the half-angle of convergence (stereoangle) from 0° to 5°.

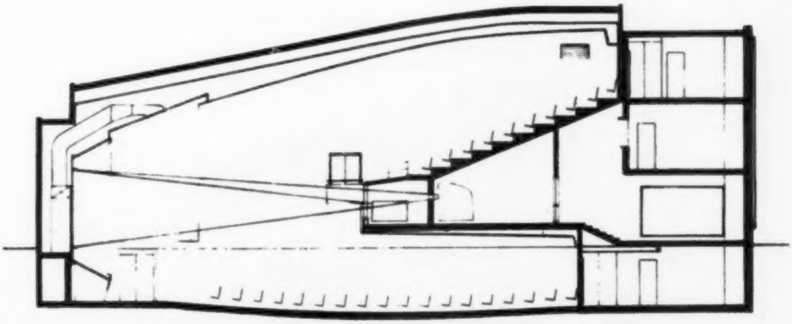


Fig. 4 Section of the Telecinema through center line.

Fig. 5. Projection room as seen by those entering the Telecinema.

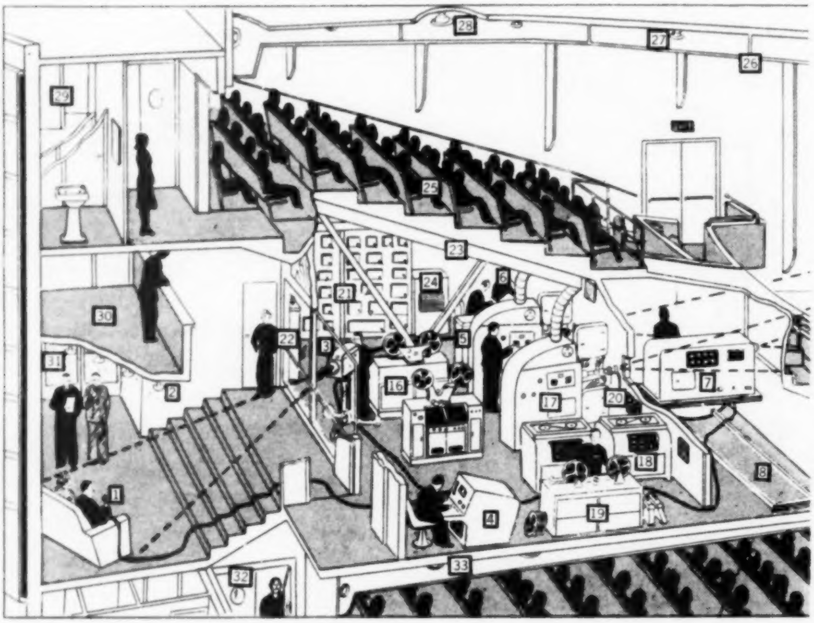


Fig. 6. Profile of the Telecinema.

Key to Television Operations

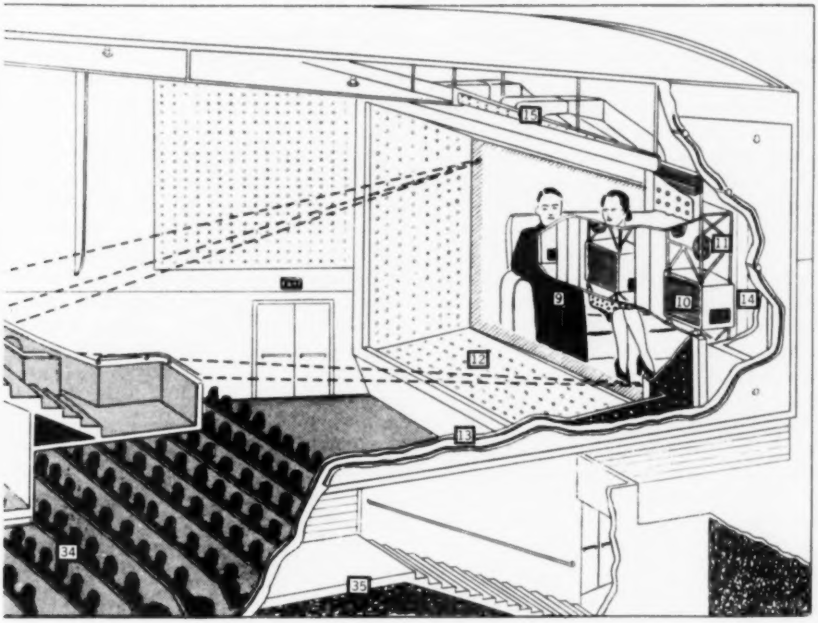
1. Scene being enacted in foyer of the theater.
2. Floodlights.
3. Television camera.
4. Sound monitor control.
5. Amplifiers.
6. TV control console.
7. TV projector.
8. Runway and turntable for TV projector when films are being shown.
9. Actual scene being taken in the foyer projected on to the high-grain screen simultaneously.
10. Main loudspeakers.
11. Auxiliary speakers which can control sound from any portion of the screen.
12. Sound frame funnels to audience.
13. Insulated main walls.
14. Insulated studs.
15. Air-control vents.

Key to Projection Room

16. Stereophonic four-sound-track magnetic reproducers, one of which is coupled to the two projectors.
17. Two projectors giving synchronous left- and right-eye pictures.
18. Interval music sound tracks.
19. Film rewinder.
20. Projector control panel.
21. Main switch gear.
22. Glass screen to foyer.
23. Vent from projectors.
24. Incoming B.B.C. Television to control console.

Other Parts

25. Balcony, 150 seats.
26. Suspended roof.
27. Roof lights.
28. Loudspeakers.
29. Entrance to balcony.
30. Mezzanine floor and manager's office.
31. Main entrance.
32. Entrance to stalls.
33. Loudspeakers.
34. Stalls, 252 seats.
35. Ground level and exit from stalls.



During the months that elapsed when this equipment was taking shape, two other projects were put in hand. In order to augment the program, it was decided to invite the National Film Board of Canada, known throughout the world for its experimental films, to undertake a three-dimensional abstract film with stereophonic music, the first to be made anywhere. Their response was most generous, and the film *Around is Around* (which was presented with the paper by McLaren[1] at this Convention) was put into production.

A Theory of Stereoscopic Transmission

Secondly, as a result of careful study of the literature of the three-dimensional film, it became apparent that knowledge of the transformations and distortions of the stereo image was still exceedingly scanty, and most of the recommendations were empirical, in spite of the excellent preliminary work carried out by Rule,[2] Norling[3] and others. The present writer, with his brother, N. L. Spottiswoode, therefore set about evolving a comprehensive theory of stereoscopic transmission, which is shortly to be published as a book of that name by the University of California Press. A single master equation determines the shape of the image under all possible variations in the camera and projection systems, while a series of about 80 subsidiary equations makes possible the design of convenient calculators, and elucidates many peculiarities of the three-dimensional image not hitherto studied.

The four films in our Telecinema program (widely different in their style and subject matter) were all produced in conformity with this theory. Today, the director of a three-dimensional film has only to state what position in the ultimate movie theater he wishes a landscape or a studio scene to occupy, in order to fit the mood or the editing of a sequence; and in a few moments

the stereotechnician beside the camera will have established the precise shooting conditions for realizing this intention. If, moreover, there are psychological factors which will tend to alter this geometrical placement of the image in cinema space, he will be able to make proper allowance for them. By the same token, the producer of an animated cartoon film (using standard one-lensed equipment) can now work with as much accuracy in three dimensions as he formerly did in two.

We owe it to the organizers of the Festival and to the British Film Institute that we were thus able to devote many months to a subject of no immediate utility, but which none the less greatly simplified the productions which were to follow, and which will, it is hoped, be of service to the industry in general if three-dimensional films come into widespread use.

Production

The special stereoscopic camera was not completed in time to shoot with it the Monopack Technicolor film which had been planned. Accordingly, the Newman-Sinclair cameras on their special base were allocated to the production of a black-and-white film which was shot in a week at the London zoo. The film is built round the character of an eminent professor who believes that an audience cannot appreciate a three-dimensional film unless it has first grasped the principles of stereoscopic transmission. (Any resemblance to the present writer is wholly coincidental!) While he becomes more and more mixed up in tangled phrases and demonstrations which don't come off, the camera cuts away to sequences which clearly show the heightened reality of the three-dimensional film.

To make possible the production of an actual film in color, Technicolor Ltd. of England came forward with the generous offer of two three-strip cameras mounted alongside one another on a base which permitted a variable angle of convergence. Figures 7 and 8 show this assembly from different angles. The simple device of a very slightly tapered wedge (Fig. 9) enabled the stereoangle to be adjusted with speed and accuracy. Parallax measurements under the traveling microscope showed that the actual parallaxes between infinity points on the two camera images differed by only 3 to 5 ten-thousandths of an inch from those arrived at by calculation. A universally jointed drive (Fig. 10) took care of the convergence angle and enabled one of the cameras to be swung aside for film inspection. The normal Technicolor selsyn system was employed to follow focus on the two cameras.

The only fundamental disadvantage of this excellent arrangement was the necessarily wide separation of the lens axes; with virtually no gap between the cameras, this distance was 9.5 in. This gave, in the theater, a stereoscopic width magnification (m_w) of about 0.25, and a depth magnification (m_d) at a mid-position in the theater of about an equal amount. This suggested that the film should be composed mainly of long shots, in which what we call extra-stereoscopic factors — perspective, masking, light and shade, and so on — should as far as possible counteract the miniaturizing effect produced by the exaggerated stereobase.

Our choice of subject fell on the headwaters of the River Thames, little known to Londoners, especially as they appear in the winter months, when the twin lenses of the stereo film camera, mounted on a moving platform, would reveal the receding planes of the bare tree branches in all their architectural beauty. Despite the worst March weather in 80 years, a short version of this film was produced in time for the Festival, and was entitled *The Distant Thames;* later a complete film, *Royal River*, took its place. In a questionnaire issued to audiences, this film received a

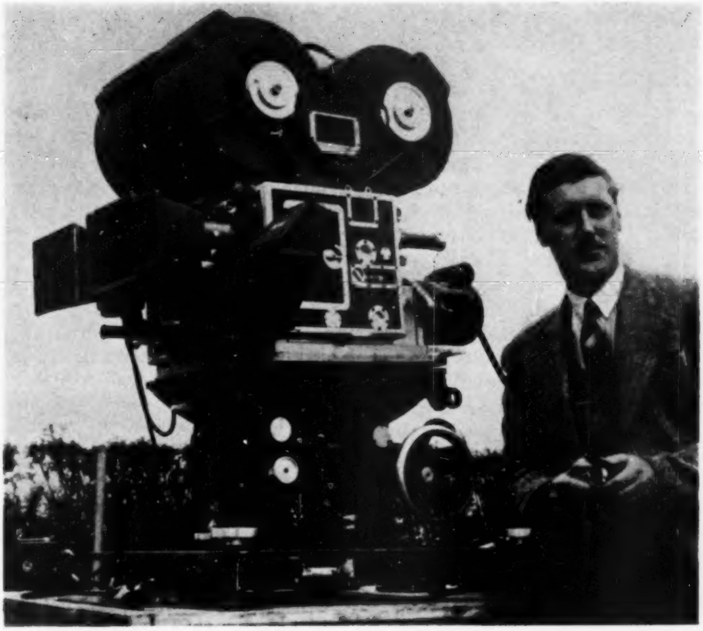


Fig. 7. Two three-strip cameras mounted together, as supplied by Technicolor Ltd.

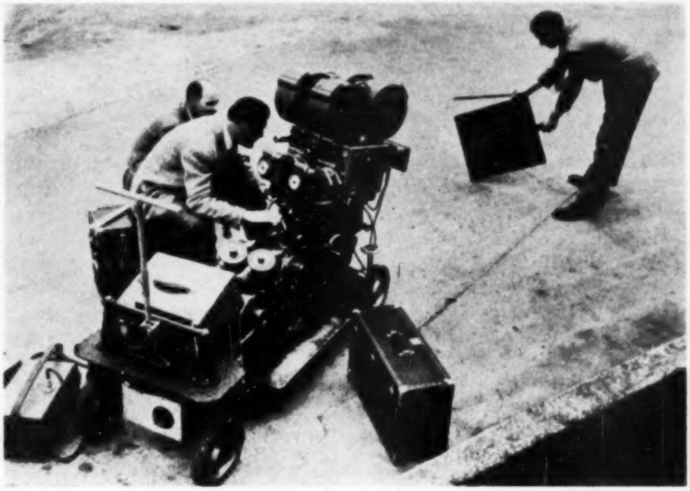


Fig. 8. Two three-strip cameras supplied by Technicolor Ltd. showing dolly.

majority of first choices over all the other films in our program.

Stereophonic Sound

Royal River, *Around Is Around* and the short introductory film, *Now is the Time to Put on Your Glasses*, were all designed for stereophonic sound accompaniment. The equipment previously outlined was completed by a special re-recording console, the chief feature of which was a set of "pan-pots" similar to those designed by the Walt Disney studios for *Fantasia*. These are variable distribution networks which enable a single input to be "moved around" to any required output sound track and thus to any required group of loudspeakers. Re-recording was carried out in the Telecinema itself before the Festival opened, and afterwards during the night, when the building was closed to the public. In this way, the precise effect of the multiple sound tracks could be judged during mixing.

Reactions to Telecinema

The television and stereo program was first presented at a world press show in the Telecinema on April 30, 1951, and it may be of interest to analyze some of the widespread reactions. It was to be expected that certain of the more tradition-bound critics should regard the stereofilm as just one step nearer to complete naturalism, and they viewed with alarm the prospect of highly three-dimensional film stars should Hollywood take up this new kind of movie. For other reasons, the trade and technical press were not altogether sympathetic. For them the three-dimensional film meant a challenge to long-established entertainment values; without the blessing of the industry, it must be regarded as an attack from outside, like television. The first response was therefore to say that it had all been done before, and wasn't worth doing again.

The public, however, caring little for these aesthetic and commercial arguments, showed great enthusiasm for the new films, and there was in fact never an empty seat during all the 1,220 performances, despite the normal commercial admission charges. Certain of the critics, moreover, showed a welcome perception of new possibilities in film. The dignified *Times* declared,

> "[In *The Distant Thames*] the sight and the imagination were being drawn into depths and perspectives the screen has never before possessed the secret of revealing.... The impact of third-dimensional image and sound is far greater and more fascinating than expectation had imagined; the spectator who has once been lent a pair of those magic glasses and, by taking them, becomes a participant, will feel like a tiger who has tasted human blood and will be content with no other."

And, towards the end of its run, the Telecinema was described by a prominent trade paper as a gold mine, and the paper urged the industry to press ahead with the commercialization of large-screen television and three-dimensional films.

This response was the more gratifying since our program was extremely modest in scope and capable of great improvement in its entertainment value. If these little films, made on a budget of a few thousand pounds, could attract such enormous audiences, and cause an audible thrill to run through the house at each performance, what would not be the stimulating effect on the box office of three-dimensional films made with all the resources of Hollywood?

It is this thought which prompts the following tentative comments on the future of the stereofilm. On the most restricted scale, we are hopeful that the Telecinema will remain in existence under the progressive management of the British Film Institute as a place where three-dimensional films and live television can continue to foreshadow the entertainment of the future. Those

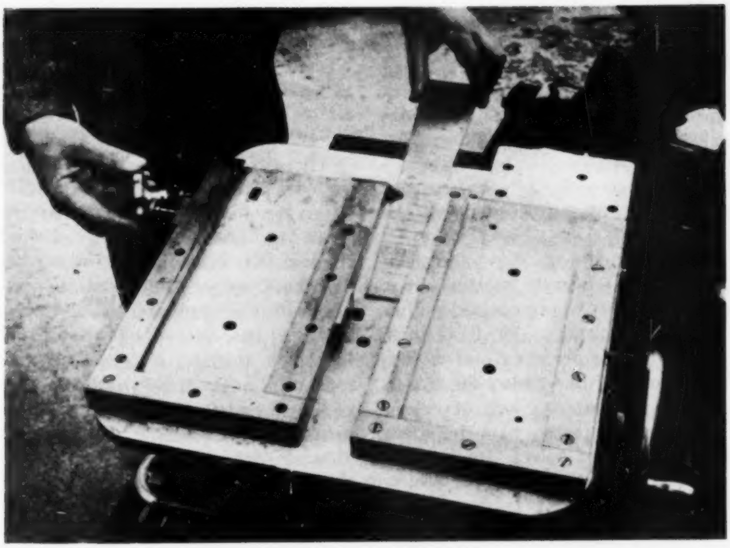


Fig. 9. Wedge used for adjustment of stereoangle.

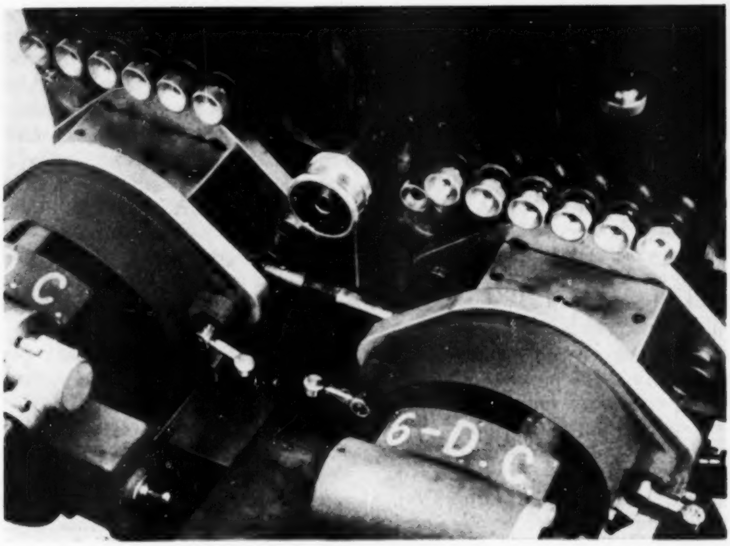


Fig. 10. Universally jointed drive for adjustment of convergence angle and for swinging one camera aside for film inspection.

responsible for this development in England intend to push forward with the production of other films. But what of the entertainment world, based on Hollywood? Will three-dimensional films, which have so long remained just around the corner — like television not many years ago — finally step out and make the flat film as obsolete as the silent film?

This is obviously not a step to be taken lightly by the industry's leaders. It is their responsibility to protect and exploit the present investment in flat films, and above all the present roster of film stars, who might not weather the transition to a far less flattering form of presentation any more easily than the silent stars who had to find voices. Hollywood will have to decide, now or in the future, whether its box-office revenues are sufficiently menaced by the attractions of other kinds of entertainment to justify so radical and therefore risky a change. The studios will also have to bear in mind that television can add a third dimension more easily than can film, and that this step forward is likely to be taken as soon as the novelty of color begins to wear off.

Use of Glasses

If these arguments are beginning to recommend a change, the industry is undoubtedly deterred by a technical consideration on which I should like to say a few words, though it demands a paper in itself. Exhibitors are almost unanimously against all three-dimensional systems which demand the use of special viewing glasses, whether of the permanent or the throwaway kind, and their objections are entitled to the utmost respect. Under the rather special conditions of the Telecinema, we feel that this problem was virtually solved. The glasses, made by the Polaroid Corp., had extremely attractive frames resembling beach glasses, and a large filter area, so that the audience was perfectly at ease when wearing them. Distribution and collection, with the aid of specially partitioned boxes, was accomplished by the normal staff of usherettes in periods of less than two minutes. Losses were small and there were no complaints of discomfort.

There is, however, among the public and the press a tendency to regard any stereo system requiring glasses as in some sense "old-fashioned" — this in spite of the fact that Polaroid was invented only 15 years ago. The following points about this system are therefore worth noting. It is the only practical system in which there is a continuous transformation of the image with movements of the spectator — in other words, there are no nonstereoscopic or pseudoscopic viewing areas. (For modern movies, the anaglyph system can be disregarded.) Secondly, the image separation is extremely efficient; under good commercial conditions, there is a leakage of only about 0.15% of each image into the "wrong" eye. No lenticular system yet constructed approaches this efficiency. There is no deleterious effect of any kind on the definition of the image, so that in adding the third dimension other necessary image qualities are not sacrificed. Finally, the conversion of theaters is cheaply and simply carried out, and the special screen is just as effective with flat pictures. These points should, I think, be given greater weight in discussion, especially when it is considered what a large part of the population wears glasses, and does not object to putting on an extra pair on the beach or when driving a car.

None the less, if two equally perfect three-dimensional systems were devised, one requiring glasses and the other not, there would not be a moment's hesitation in picking the one to use. It is therefore worth considering some fundamental points about these "glass-less" systems. Firstly, the problem of image selection at the screen is very much more difficult than most inventors think; many able men are working today on

systems which have long ago been abandoned as profitless, or can be demonstrated as having no future. A few inventors — notably Ives, Kanolt, Noaillon and Gabor — have made fundamental contributions in the motion picture field during the last 20 years. The best treatment of this subject is the little-known group of patent specifications by Dennis Gabor,[4] whose research was carried out for the British Thomson-Houston Co. in England.

Two basic and very serious problems are made clear by this work. First, that the image-separating screen is of formidable complexity, and requires separate calculation and construction for each theater, according to the placement of its seats. Second, the resolving power of the lenticular structure gives an image definition much lower than would be acceptable for feature films, unless a manufacturing technique is assumed which is far ahead of what can be accomplished today. Thirdly, if the audience's heads are not to remain rigidly fixed, as in the Soviet system associated with Ivanow, a plurality of images must be provided for each eye, so that the eyes pass smoothly from one viewing zone to another and not into a position of blurred or pseudoscopic vision. The stills displayed in shop windows benefit from this plurality of images, because they give the passerby the illusion that he is walking past an object which he can see "in the round." But the moviegoer is essentially a stationary person, who is fully satisfied with the single view of the world which flat films have long given him. Hence the multiple views required by lenticular systems (to permit random head movements) are in a very real sense wasted. When it is considered that the storage capacity of 35mm film is already strained to the limit by the demands of high picture resolution and almost perfect color reproduction, it will be seen that the requirement of multiplying this capacity by a factor of 5 or 10 puts an impossible burden on the manufacturers of film.

Thus we have the contrast between a virtually perfect system, simple and inexpensive, which requires glasses; and systems dispensing with glasses which are today far from practical attainment, and which almost certainly would not repay the huge sums needed to develop them further. I believe that there is a way out of this dilemma, and that it is to be found by harnessing the science of electronics to solve some of the problems which are too refractory to be dealt with by optics.

For the Future

In all that has gone before, it has been assumed that the three-dimensional film meant the true binocular film, and not the flat film as projected on a giant screen, or spread out to the limits of vision, as in the Cinerama process. It is certainly true that a wide field of view enhances the feeling of being "in the scene," and is thus necessary in any attempt to give audiences a stronger sense of participation in the dramas of the screen. But I do not feel that there is any adequate substitute for true three-dimensional presentation; nor do I think that anyone who has worked extensively in this field and watched the reactions of audiences to these "films in space" would willingly revert to the flat films of today.

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The Cash Customers

at the Festival of Britain Telecinema

By NORMAN JENKINS

This informal report describes the reaction of the audience to a most unusual programme of large-screen television, plus stereoscopic films accompanied by stereophonic sound.

THE SPONSORS, The British Film Institute, who have also commissioned the special equipment necessary, claim that the Telecinema is the first place in the world in which big-screen television, three-dimensional pictures and stereophonic sound can be seen on an equal footing with the established sound film.

The South Bank Exhibition of the Festival of Britain houses the Telecinema (officially the Telekinema), the title of which forces me to apologize for those of my countrymen responsible. For everything else all concerned deserve the highest praise mixed only with the modicum of criticism I feel it is necessary to record if only for the sake of objectivity.

The auditorium of the Telecinema is long and narrow, quite unlike the rather broad type of cinema to which we have been accustomed by building which took place in the thirties. There has, of course, been no building of cinemas after World War II.

The theatre walls cut square into the proscenium. This looks like nothing more than a modern picture frame which appears to be of material, five or six feet wide, splayed inward and neatly mitred at the corners. The flat faces are perforated and the substance looks rather like Celotex or other proprietary sound insulation sheeting. The holes are larger, however, and the material is continuous rather than in tile form.

The space between the proscenium and the screen proper is all screen. That is to say the whole proscenium opening is projection material of a specially curved metallic surface. The central portion is used for the picture and the peripheral space used for the projected surround.

The surround consists of a variable intensity of either white or coloured light. For television the surround is fixed value coming from a standard slide projector. For films the light

A contribution which Norman Jenkins, 16 Rozel Rd., London S. W. 4, England, has made in response to a request by Society headquarters.

comes from a reflex arrangement which uses the picture itself, a few frames in advance, to modulate the light from the lamphouse of one projector.

Please note that the theatre walls cut into the proscenium and next comes the comparatively narrow surround, then the picture. Compared with the cross section of the theatre at that end the picture size is large.

In the space of a very few months equipment has been planned and manufactured and a cinema designed and built. In the same space of time the technique as well as the technics of large-screen television, stereo-cinema and stereophonics have been developed. All of these entirely variable and theoretical concepts have become actualities now earning money and indeed playing to completely full houses at every performance seven days a week.

Of the equipment itself, the design of the cinema and the technics generally, I propose to say very little. Raymond Spottiswoode, who is technical director of the project, has contributed a paper describing these in far greater detail than I obviously could do. [That paper, with illustrations, also appears in this issue of the *Journal*.] My interests are largely in detailing some of the reactions of the cash customer.

To know the reactions of the cash customer is, of course, vital to the establishment of any kind of commercial service of stereoscopy and stereophony in film entertainment and large-scale television. Whether or not I am best fitted to make the necessary observations I cannot say and for that reason the Society's Board of Editors has permitted me to make this purely personal contribution, deliberately personal, with but individual responsibility for the opinions expressed. I should further explain that I have no commercial interests whatever in cinema entertainment, but I have what I believe is a very wide technical knowledge and experience developed simultaneously with a most critical experience of cinema-going: in short, a film amateur, a professional cash customer.

First Visits

The first time I visited the Telecinema was before the exhibition opened officially. The attendant gave me a pair of stereo spectacles and showed me to a seat while part of a stereoscopic short subject, *The Distant Thames*, was being projected to an extremely small audience. I must say I regretted this experience, not only because it thrust me into a purely private showing but because I was not a part of a normal audience seeing a properly staged show.

Nevertheless, I was tremendously impressed by the cinema itself, the décor, the proscenium and even the attendants. I have seen less distinguished appearing and far less soignée programme sellers at charity shows. The chic clothes they wore and their air of friendliness were so exactly right as to baffle description.

For the part of *The Distant Thames* I saw, I had considerable difficulty in resolving sharp definition. I have since come to the conclusion that the fault was probably then in the equipment or its adjustment. Subsequent viewings have found the film sharp enough.

At the end and after the lights had gone up I was literally startled to hear a number of birds cawing and chirruping loudly in the course of flight around the auditorium. I knew, of course, it was reproduction and that was what I had come there for, but it was the first time I had become conscious of the stereophonic sounds. I had not noticed anything like it during the running of the film.

For some reason or another I was not invited to the press show. The national daily press greeted the programme with enthusiasm and was followed later by the technical press in similar terms. What few reports I saw in the technical papers were all favourable. I have

avoided reading all the reports heretofore because I did not wish to form any kind of bias before writing this report. The first regular showing I did attend was during the first two weeks. Unfortunately, the sound broke down, for a period entirely, and for the rest only a single track was used so there was no stereophony. In my later visits there was no interruption due to technical difficulties.

Large-Screen Television

This was the first time I had seen the large-screen television and although I had been discussing this with the cinema manager, Mr. Hazell, who had come to the South Bank from the Odeon at Penge where he had been accustomed to large-screen television, it was some time before I realized what I had been looking at.

The large-screen television programme has, from the opening day, commenced by showing the entry of the first cash customers. The performances are separate and whilst the house is filling the projector is running and showing a picture. This is picked up from the main entrance foyer, where not unduly bright lights suffice for the Marconi camera. Those in the auditorium see others entering and proceeding to the staircases.

When I entered the nearly full circle and saw a picture on the screen the thought did not register that it was a televised one. I was in just the mood of observation, rather than criticism. The picture was good, large and somewhat soft in tones of grey rather than black, but apart from that it looked rather like average to good 16mm. It was not until the commentator began speaking that I realized what it was and not then until he moved his head and body. When he did this the lines showed momentarily, sinking back into the picture on cessation of movement.

The number of lines used by Cinema-Television Ltd. is the same as that used for BBC transmissions. I am not a television user (speaking personally again, I do not see my money's worth in the possession and use of a receiver) and see programmes only occasionally. My memory of them, both prewar and recently, had led me to expect large-screen television to be something far more crude than this and much less acceptable. The best pictures I had previously seen were on a nine-inch tube and even the lines showed more than I, a film man, could accept. But this large-screen television is good by any standard.

Both on this and on subsequent visits I found that the audience would laugh at the least funny incidents. At the first large-screen television show I saw, I can well remember the commentator doing a live and impromptu interview with a gentleman from Mauritius. The latter was nervous and had a little trick of licking his lips. Every time his tongue came out the audience laughed and with repetition became hilarious. I wondered what the man himself must have thought if he had heard the laughter. After all, he was only in the foyer and his audience not more than a dozen feet from him.

The incident reminds me of the extraordinary feat of sound proofing which the architect and his technical advisers have done. Charing Cross railway bridge (Hungerford Bridge) is at no great distance from the outside of the cinema and the noise from a dozen or so rail tracks is practically continuous. Inside the cinema there is no detectable sound.

But to revert to the audience for television. At other shows I have noticed that the people coming in and behaving anything less than completely phlegmatically will raise a laugh, whilst the commentator can also raise a laugh for very little. I take this as part evidence of a rather specially conditioned audience. These folk have been waiting in line for an hour or more to get in.

Before that they have been tramping round a concrete floored exhibition getting more and more footsore. Almost any kind of well padded seat would have special attractions. But in addition the character of the exhibition must be added to the evaluation. This show is like nothing else they have seen and is an inspiring and uplifting experience. They have seen some remarkable things, presented in a most unusual way.

This audience is in a definable frame of mind as I see it: everyone is expecting something unusual. They have, after all, come to see stereo films and hear stereo sound, and to see large-screen television. They expect these things to be of a quality similar to those other strange and remarkable things they have seen. This audience is not likely to be critical, it is ready and eager to be amused, a "natural" for a comic. I think many showmen will know exactly what I am driving at.

The Picture Programme

Dodging backwards for a moment it is worth taking a look at the programme. It has been the same one for all these months and it is very likely that beyond minor adjustments it will continue without alteration until the close of the show.

First of all there is *Now Is the Time.* There is nothing quite like this in the average cinemagoer's experience. It is animated cartoon, but with the possible exception of short shorts advertising the usual soap or cigarettes, there is no point of contact. This film is, of course, stereoscopic and in colour and has the added unfamiliarity of synthetic sound — photographed patterns.

The next film is *Around Is Around.* This is another film with no point of contact with usual cinematic experience. Briefly, the stereo pairs of this film are produced by the traces of cathode-ray tubes, synthetically displaced and photographed in color. The sound tracks of this film are recorded in multiple and in depth and width — stereosound.

The next film is really typical of the average magazine reel. (I mean absolutely no disparagement; I know too well the compelling circumstances normally applying to newsreel magazine production.) *A Solid Explanation* was made in black-and-white by the Pathe Documentary Unit of Associated British-Pathe Ltd., and is a one-set background for a commentator somewhat heavy-handedly explaining that stereoscopy is a matter of to and from, as he does this and that, and as to the zoo animals he describes. The aquaria and outdoor zoo sequence that follows go to form the only familiar scenes of comparison.

The Distant Thames is a perfectly straightforward piece of photography of the river and as such should form a point of contact. Unfortunately for this contention almost all of the film is in motion. There is a very short sequence at Windsor Castle where the zoo film technique is merely duplicated in Technicolor.

It is, I think, well enough known to both technicians and film producers that a camera moving sideways across a subject, or better still around it in an arc, will produce an illusion of stereoscopy, even in a two-dimensional film. Paramount, I believe, tried (or succeeded, I just don't know) to patent this for a series of animated model-cum-cartoon films they produced in the thirties. Well, *The Distant Thames* confuses the issue by spending an estimated 98% of its footage in sideways or forward (very little) movement. I do submit that this is an unusual experience for cinemagoers.[1] The sound accompaniment for *The Distant Thames* was post-recorded stereophonically in the Telecinema itself.

The concluding film in the programme is a cartoon in a most unusual technique. It consists of a static series of illustrations to the recitation of "John Gilpin." None of the illustrations moves. The pictures are in black-and-white only.

The camera moving across in certain sequences and quick cutting in others livens up the fast action demanded by the story. You know about John Gilpin, perhaps? He was a citizen of credit and renown. He went on horseback for a pic-nic to the Bell at Edmonton.... The sound accompaniment is nonstereophonic.

Details of the films and the credits are familiar to many, for the technical press has been generous in giving space to publicize this venture into the unknown. From those reports I have seen I must remark how little criticism, either informed or otherwise, has been offered: it has mostly been purely descriptive and noncommittal.

Audience Reaction

The reception given by the audiences present at those times when I have visited the cinema has been near enough the same as far as I can judge. The first film opens to an appreciative hush, following polite applause for the television commentator. The donning of the stereo spectacles causes a hum of excitement and anticipation, although there must have been many who remember the MGM prewar stereo films, when the more familiar red and green (and nonreturnable) cardboard viewers were used. The man behind me last week made a loud reference to the fact that this was nothing new.

The effect of depth in *Now Is the Time* is instant and clear cut. I do not suppose there is anyone in the whole audience, unless one-eyed, who could not appreciate this. The picture is brilliant and as well illuminated as any normal cinema screen. It is only 15 feet wide anyway and there are two 50-ampere arcs kept at a constant level, one for each of the overlapping pictures.

As the animated drawings moved forward, apparently out into the auditorium, there were always some gasps of surprise and laughter which, by the end of the programme when the swans of the Thames film did the same with their long necks, had sobered down considerably. Numerous children stretched out their hands to see if they could touch the images. Applause after each film, by the way, was generous to start with but faded away.

The musical accompaniment of *Now Is the Time* is so appropriate, synthetic as it is, that the novelty and to some extent eerie effect of the film is enhanced. This film and *Around Is Around* are so much in tune with the spirit of the exhibition of which the Telecinema is a part that I for one, when I first saw this programme, felt a thrill of new experience.

I wish that *Solid Explanation* formed no part of the programme and that *The Distant Thames* had perhaps been replaced with another, or had been placed at the commencement of the programme. I have been left with very mixed feelings: either this programme should have been, as it is represented as being, a true means of comparing stereoscopic films with the normal cinema, or it should have been so completely experimental that there was no point of comparison.

As it is, with the comparison that is made by *Solid Explanation* and *The Distant Thames*, completely realistic as is the one and quite beautiful as is the other, there is but a poor impression to be gained from the first and no comparison of value that can be made with the second. It is not as though *The Distant Thames* can be compared with any recognizable technique in travelogues or documentaries. This film relies on the natural beauty of the subject and two technical tricks, one forward motion and the other stereoscopy. Of the effect of stereo sound, please note later comment.

Of the effect on the audiences there is not much more that can be said factually. Of the impressions I have gained from listening to several performances — listening, that is, to comments in the locality of my own seat

and chatter from folk on the way out — and from discussions with others who have seen the programme either with me or at other times, I have gathered the following. Most folk are sufficiently impressed to speak of their experience as "wonderful" and regard the whole thing rather as a technical miracle. What they have to say to their friends intrigues sufficient numbers to keep a queue outside waiting up to a couple of hours for a performance — but I have yet to hear people saying "you *must* see the Telecinema" in the tone adopted to recommending a feature film of the quality of, say, *The Lavender Hill Mob*.

Incidentally, if you saw and liked *Kind Hearts and Coronets* you will know that Alec Guinness and the Ealing Studios comedies can be good. They excel themselves in *The Lavender Hill Mob*. It is not yet on general release and will certainly be passed on from one to another as a "wow." But I fear that the effect of stereoscopic films and stereosound does not even equal that of an unusually good feature film.

Audience reaction to the programme as far as films are concerned has been dealt with but this report would not be complete without some reference to the effect on the audience of the remainder of the technical effort. Although the architecture and equipment are not considered in detail in this paper, I do feel it necessary to explain the effect of the proscenium design in relation to the screen size and the system of projected surround, and also to mention the effect of the loud speaker placement and the effect of stereosound.

Modulated picture surround was tried out by British Thompson-Houston engineers when the Odeon Cinema in Leicester Square was first commissioned and this, the Telecinema, is the second attempt. I believe that neither experiment is conclusive. As far as the Telecinema is concerned, it is my personal opinion that the proportions of the screen end of the theatre, the screen size, the proscenium and the surround are by no means right.

But that depends upon the initial intention. If all concerned were of the opinion that stereoptics and stereophony would make the cinemagoer think he was in the picture and of it instead of merely being a privileged spectator, a dreamer of clear-cut dreams, then in my opinion such an idea is proved to have failed. The effect of the present design is very effectively to present a window, through which unusually beautiful effects of depth in recession may be observed and occasional effects of depth in protruding procession.

I am sure Mr. Spottiswoode, who is much more qualified than I am, can explain why this is so because the change in effect is so marked. In one case everything is *in* the theatre and in the other everything is so much smaller and seen *beyond* the window frame.

I have done much experimental work myself in projection with the object of creating the perfect illusion and have found to my own satisfaction (the personal aspect of these comments must not be lost sight of) that the best effect is obtained by aiming at a picture suspended in space, a picture materializing, as it were, in one's own home or in the theatre where there is no surround noticeable at all. It is a remarkable fact that the continent of Europe has not taken so much notice of the necessity for proscenium design as we have here in the United Kingdom. In France, Belgium and Holland I have noticed that the picture is usually far too big for both proscenium and theatre in just the same way as at the Telecinema.

I do not wish to make this an opportunity for airing my own theories, but I am not yet convinced one way or the other of the efficacy or necessity for a picture surround. In seeing superimposed subtitles on foreign films I have noticed, as others may also, that white lettering gains contrast where it appears on areas of picture that are not

necessarily black, or if they are on black then where the letters are near to areas of light tone — not necessarily, again, of completely white areas. That is not very well expressed, perhaps, but it is descriptive of a transitory effect and may strike a chord in those who have had similar experience.

Assessment of the Stereosound

Of the stereosound in the Telecinema I must say that from personal experience it is by no means as successful in illusion as the stereo picture. The latter is noticeable from any seat and from any angle. The depth in sound is effective from central seats only and best from the central seats in the circle. In side seats there is an occasionally noticeable roving sound.

On the occasion of one visit I had a downstairs seat on the left-hand gangway, about one quarter or less from the back wall. By dint of knowledge and conscious effort I could hear sounds coming from the rear and side, but only when I decided that I ought to be hearing them in that manner.

Subsequent visits and some thought given to the troubles I knew the recording people were experiencing have produced the opinion that it is the methods used as much as the natural circumstances which are responsible. For instance, in *The Distant Thames* bird noises are supposed to travel round the auditorium. They do, undoubtedly, but background music appears to have no direction, or else it comes from the screen end only. To me, there was auditory confusion. If at any one moment only one sound direction were used and a directional sequence were employed to make that sound travel, the illusion would succeed whatever the position of the hearer.

The only check employed was to question a neighbour on the downstairs gangway in deliberate non-clue language. I asked him "What did you think of the direction of the sound." He had no idea how, or reason for answering, to please and said "Why! from the front, I suppose." Both of us were within ten feet of one of the nearer rear speakers but he certainly hadn't noticed anything coming from it. And I had only by conscious effort. The point was confirmed by a friend a little further to the rear on the same occasion.

From the same seat I did notice that sounds following movement in depth certainly did so with considerable realism but I question whether it was better done or results were better than first-class recording and a normal single-channel system would produce.

Having made these remarks by way of criticism and for the record it would be wrong not to say that in summary there is here at the Telecinema a concrete example of very considerable and noteworthy achievement. Theoretical concepts have been brought to reality in a remarkable space of time and if some of them point to ways which should not be followed, then they may equally point to ways that must. Someone at some time had to make a start and it is with national pride that we here see that the British Film Institute has taken the lead.

The Telecinema is to stay. It has a site that no one is likely to covet and it is to be hoped that sufficient money has been taken at the door during the exhibition to finance more experiment. I am certain that when dialogue, for instance, is recorded and characters to left and right are heard to speak, as is usual, one at a time, then the effect of stereophony will be much more easily heard and understood than at present where unplaceable noises have to fight for their presence with overall background music.

I am looking forward with the keenest pleasure to seeing more and more programmes not only in the Telecinema (whose title I hope they will change but I fear they won't) but also in the

general run of cinemas. There is nothing in the equipment, either in the large-screen television or in the stereo systems to prevent this — there is only expense.

To the average cash customer I think the Telecinema was a passing novelty, and a glimpse into the future. To me, and I am sure to many other technicians, it has been a tremendously impressive experience and certainly a privileged occasion.

The professional reputations of those concerned have been very considerably enhanced by the universally favourable and successful reception given to the realization of their efforts. I would like permission to name them all.

Those Responsible

Architect, Dr. Wells Coates

Programme Producer and British Film Institute Representative for the Festival, John D. Ralph

Technical Director, Stereofilm Production, Raymond Spottiswoode

Supervisor of Television Production, Malcolm Baker-Smith

Cinema Manager, A. F. Hazell

Stereophonic Recording, Ken Cameron (By courtesy of the Crown Film Unit)

Stereo-Projection System, The British Thompson-Houston Co., Ltd.

Stereosound Recorders and Reproducers, The British Thompson-Houston Co., Ltd., and His Master's Voice

Large Screen Production Television System, Cinema-Television Ltd.

Optical-Magnetic Sound 16mm Projector

G. A. del VALLE and F. L. PUTZRATH

Heretofore, the task of recording sound on 16mm film has been a job for the engineer and the most aggressive amateur. With the advent of successful striping of 16mm film with magnetic coating, synchronized sound with picture is now a reality for a greater number of people. The instrument described in this paper has been designed to record, reproduce and erase magnetic sound track, as well as to reproduce photographic sound track of 16mm film.

Ever since iron oxide coated tapes became an accepted medium for sound recording, the possibility of applying the same material to 16mm motion picture work has been very evident. Work in our laboratories at Camden for developing and designing equipment to handle this film has been going on for several years.

The problems of applying the narrow strips of magnetic material to 16mm acetate stock have not been simple, and this doubtless explains the relatively late appearance commercially of magnetic sound on 16mm film. Reeves Soundcraft Corp. made satisfactory film samples in the latter part of 1950. Magnetic stripe on 16mm and 8mm was earlier described and demonstrated by Marvin Camras.[1,2]

Presented on October 18, 1951, at the Society's Convention at Hollywood, Calif., by O. B. Gunby, for the authors, G. A. del Valle and F. L. Putzrath, Radio Corporation of America, Engineering Products Dept., RCA Victor Div., Camden 2, N.J.

The projector that we are about to describe is basically an RCA 400 Senior projector (Fig. 1) which has been modified to accept the component parts required for recording and reproducing magnetic sound track without altering, in any way, the characteristic simplicity of its threading.

This projector actually performs four functions: (1) It reproduces photographic sound track; (2) it erases and records magnetic sound track; (3) it reproduces magnetic sound track; (4) it can be used as a public address system. Any one of these four functions can be chosen by simply turning two knobs, one (Fig. 2) to select the amplifier operation desired, and one (Fig. 1) to select the type of sound track to be played. Recording level is checked by a glow-lamp indicator which is located on the upper portion of the amplifier panel.

For recording and reproducing magnetic track, a very small record-play

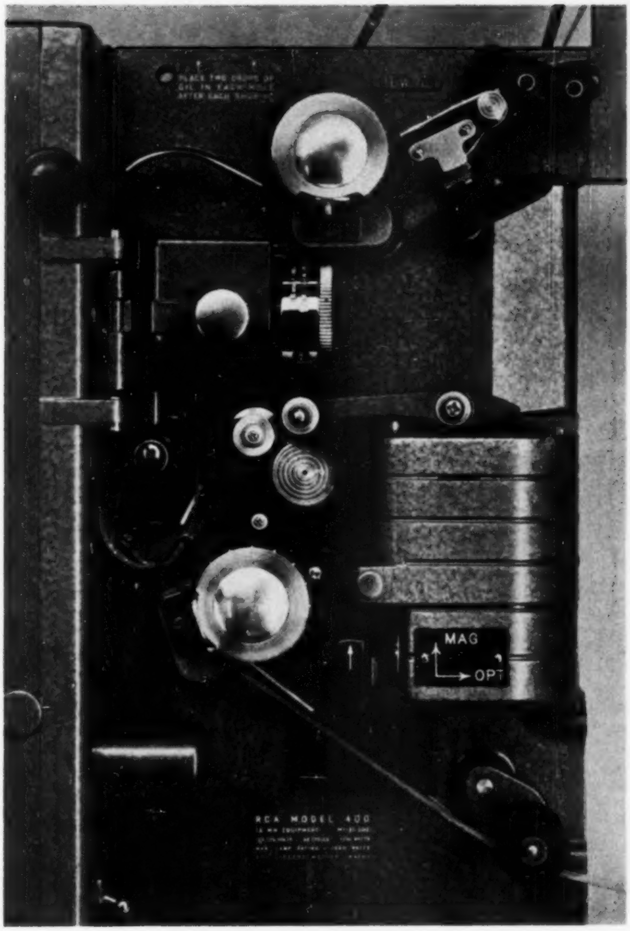


Fig. 1. RCA-400 magnetic projector showing location of erase head, and track-control switch.

combination head has been mounted inside of the sound drum, as shown in the partially disassembled view, Fig. 3. The erase head has been mounted just ahead of the upper sprocket, Fig. 1. The location of the record-play head inside the sound drum offers several advantages over any other location. The constancy of film motion is optimum at this point and the distance from sound to picture can be maintained exactly the same as that standardized for photographic and proposed for magnetic tracks.

Anyone familiar with the behavior of 16mm acetate stock can readily understand the difficulties encountered in obtaining good physical contact be-

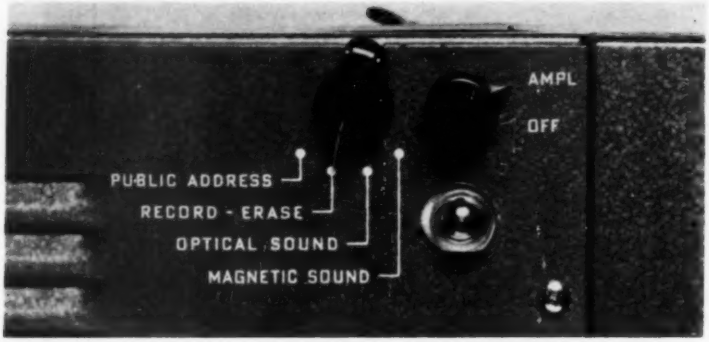


Fig. 2. Amplifier function selector switch. Signal level indicator is shown just below switch knob.

Fig. 3. Sound drum partially removed to show magnetic head assembly

tween the magnetic head and the track on a film that may be anything but flat. In the RCA 400 magnetic projector good physical contact has been obtained between film and head consistent with low head wear and low film deformation. The head is mounted on the free end of a hinged, spring-loaded arm which also automatically compensates for head wear.

In order to obtain maximum tracking of the head (Fig. 3) against the film, it was found necessary to provide four distinct adjustments for the record-play head: azimuth, lateral, pressure and bearing adjustments. For the purpose of adjusting the magnetic gap for azimuth, or perpendicularity in relation to direction of travel of the film, the magnetic head has been de-

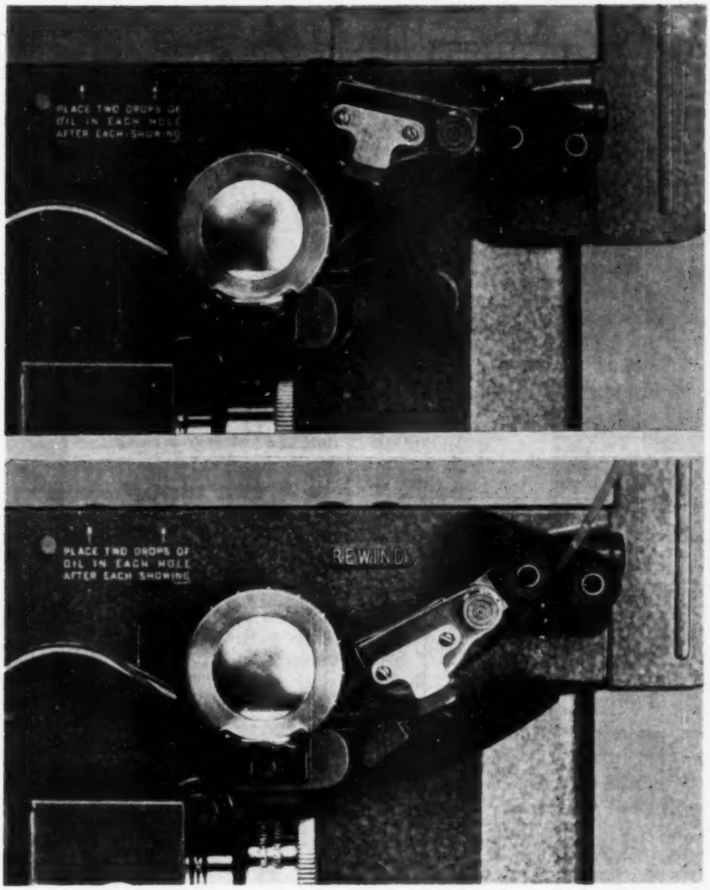


Fig. 4. Erase head and rewind lever.

Above — On "rewind" position. Below — On "Operate" position.

signed to fit a circular cavity in the arm, the center of which should lie in the exact center of the magnetic gap longitudinally and transversely. It has been found that this adjustment can be performed accurately with the aid of a high-power toolmaker's microscope.

For the purpose of centrally locating the magnetic sound track in relation to the width of the pole piece (or lateral location of film) the same adjustment is used as was originally provided for photographic sound track, i.e., axially moving the roller which guides the film into the sound drum. The photographic track is adjusted by means of a split threaded bushing located at the anchoring point of the exciter-lamp bracket.

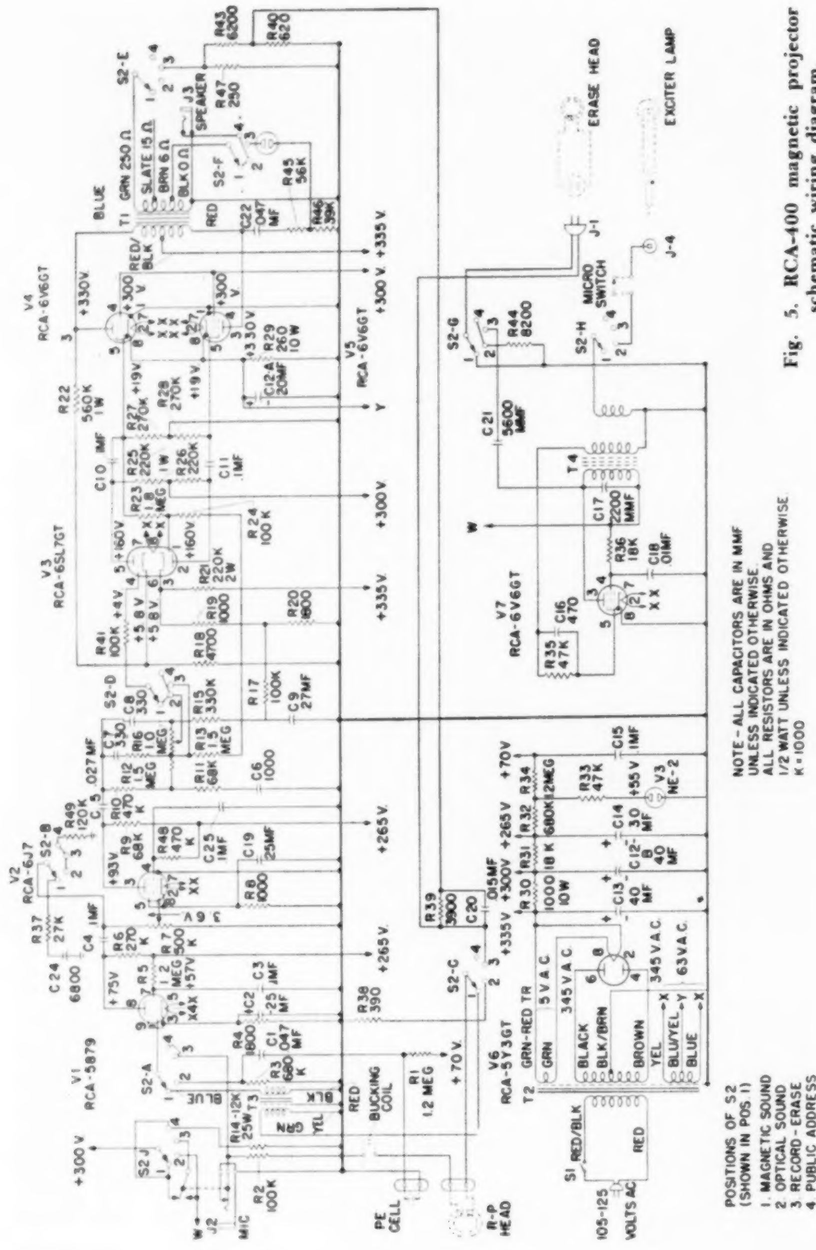


Fig. 5. RCA-400 magnetic projector schematic wiring diagram.

The amount of pressure between head and film is controlled by merely turning a set screw. A nylon insert, through which this setscrew passes, locks the screw in position.

The last adjustment of the magnetic head is to obtain the best possible alignment of the magnetic head film-bearing surface in relation to the curvature of the sound-drum periphery. This is obtained by rotating an eccentric bushing which is located at the fulcrum point of the arm supporting the magnetic head. This adjustment is performed by rotating the eccentric bushing until maximum output from a high-frequency recorded track is obtained.

The erase head has also been mounted on a hinged arm (Fig. 4) but for a different purpose. Perhaps one of the weaknesses of magnetically recorded sound is the possibility of unintentional erasure of the recorded signal. In the RCA 400, rewinding of film is accomplished by merely threading the tail end of the film into the upper reel, tripping the rewind lever, and starting the projector.

To render the projector as nearly foolproof as possible, interference was intentionally provided between the rewind lever and the erase head. In other words, upon completion of a recording, the erase head must be moved out of the way to permit the rewinding of the film. This automatically removes the erase head from the film-threading path. One can erase only when the erase head is deliberately pushed down into position and the film threaded through it. Besides this precaution, it is also necessary to turn the function-selector switch in the amplifier to the *Record-Erase* position and to insert a plug in the input jack. If any one of these last two operations is not performed, the erase head will not be energized. For efficient erasure of the recorded signal, it is also essential that good physical contact be maintained between the sound track and the magnetic gap. For this purpose, we have provided a small plastic shoe with very light pressure which holds the film directly against the magnetic gap of the erase head.

Two guide rollers (Fig. 4) have been provided ahead of the erase head. These rollers maintain the film at a constant angle as it enters the erase head independent of the reel diameter.

As mentioned before, the projector reproduces photographic track. This is accomplished by merely placing the selector switch (Fig. 1) in the *Optical Sound* position and the track selector on *Optical*. When the track-selector knob is moved to this position, a microswitch completes the circuit for the exciter lamp and at the same time the magnetic head is retracted to prevent it from making contact with the film. These two precautions not only make it mandatory to turn the track-selector knob to obtain exciter-lamp excitation, but also make it impossible to scratch the track as it passes over the magnetic head when reproducing photographic sound.

The amplifier described in this paper is somewhat similar to the one used in the 16mm Senior RCA 400 Projector. The original amplifier employs one pentode and two triode voltage amplifiers, one triode phase inverter, and push-pull pentodes in the output with an inherently stable feedback circuit. The input is taken from either a photoelectric tube or a microphone. The amplifier delivers 10 watts into a 6-, 15- or 250-ohm load. A volume control and a tone control (which tilts the frequency response about an 800-cycle center frequency) are provided. The polarizing potential for the phototube is regulated by means of a glow lamp. An rf oscillator supplies power to the exciter lamp.

The new amplifier model (Fig. 5) meets all the performance requirements of the standard projector and, in addition, has all the facilities necessary for

the recording, reproducing and erasing of sound on the magnetic-coated film. The modification of the amplifier has been accomplished mainly in two steps:

(1) The gain of the amplifier proper has been increased by substituting a pentode for the triode voltage amplifier, resulting in the following tube complement:

1 — 5879 voltage amplifier,
1 — 6J7 voltage amplifier,
1 — 6SL7GT voltage amplifier, phase inverter,
3 — 6V6GT push-pull output stage, rf oscillator,
1 — 5Y3GT rectifier, and
2 — NE-2 voltage regulator, recording level indicator.

(2) A 9-pole, 4-position switch has been used to permit the selection of any one of the previously mentioned projector functions.

For the reproduction of magnetic sound (S2 in position 1) the record-play head is connected to the primary of the input transformer, the secondary winding of which is connected to the grid of the first voltage amplifier. The turns-ratio of this transformer was chosen so that the resonance between the inductance of the record-play head and the distributed capacity of the transformer secondary falls slightly beyond the useful audio range of the system. A special load is connected to the plate circuit of the first voltage amplifier giving the required low-frequency compensation. The signal then goes through the regular amplifier path, including the pentode and triode amplifiers with their volume and tone controls, the phase inverter, and the push-pull output stage. The amplifier load is the speaker. To avoid possible erasure of the magnetic film no plate power is applied to the oscillator tube. However, a dummy load maintains a constant load on the power supply.

For the recording of sound on the magnetic film (S2 in position 3) the grid of the input is connected to the microphone. The signal follows the regular amplifier path except that the tone control circuit is disconnected, insuring a "flat" recording characteristic. The speaker load is disconnected to avoid accidental acoustic feedback. In its place, a dummy load is connected across a 250-ohm output winding. A suitable voltage divider across this load feeds the record-play head through the compensation network (R-39 and C-20). In order to avoid accidental erasure the oscillator receives plate power only while a microphone plug is inserted. The oscillator load is connected from the primary side of the transformer and is formed by a series-parallel combination of the erase head, the record-play head, C-20, R-39 and R-40. Thus, the mixing of the audio and biasing currents for the record-play head occurs between the head and the compensating network. The switch section which was used to disconnect the speaker load now completes the circuit of the recording-level indicator, an NE-2 tube. The resistive network associated with this indicator is adjusted so that the indicator flashes at a signal level slightly below the overload point of the film.

Several problems were encountered in the design, layout, and location of the amplifier and its associated components along the film path. In order to avoid distortion and high hiss-level, it is imperative that no residual magnetism be left in the record-play head. Thus, means must be provided to decrease the bias current in this head to a small value before it is entirely removed. In this model a step-by-step bias attenuation is accomplished automatically when the amplifier is switched from the magnetic recording position. In particular, S2-J (being a shorting-type switch) temporarily parallels the oscillator tube and the dummy load that otherwise takes its place. Thus, a reduction in B-supply voltage is

effected, decreasing the recording-head current. S2-G and S2-H (also of the shorting type) temporarily load the oscillator tank primary and recording windings with R-44 and the exciter lamp respectively also effecting a decrease in bias current. Similarly S2-C shunts the record-play head with R-38. Since these means of reducing the bias current in the record-play head will occur successively in some random sequence, the head will be left in an essentially de-magnetized state at the time when the biasing current is completely removed. If the microphone jack is removed while S2 is in the *Record-Erase* position, the capacities associated with the oscillator will permit exponential decay of the amplitude of oscillation.

Because the amplifier is used for four different functions, careful layout of the wiring and switching is required. Since one head is used for recording as well as playback, connections between the amplifier output and input are required. To gain some measure of isolation in this circuit the available intermediate switching contacts are essentially grounded. There is also a tendency for the oscillator signals to be electrostatically coupled into the amplifier proper. Careful wiring again limits these signals to levels sufficiently low to avoid adverse effects on the amplifier operation.

The external magnetic fields of the power transformer, the motor and the projection lamp are of sufficient magnitude to introduce hum into the circuit components and wiring. The effect of these hum generators is somewhat reduced by adjusting their physical location as far as feasible. Thus, the motor and power transformer are located as far away as possible from the record-play head. The motor can be rotated axially and the transformer, being supported in a special mounting, can be physically adjusted to give minimum hum interference.

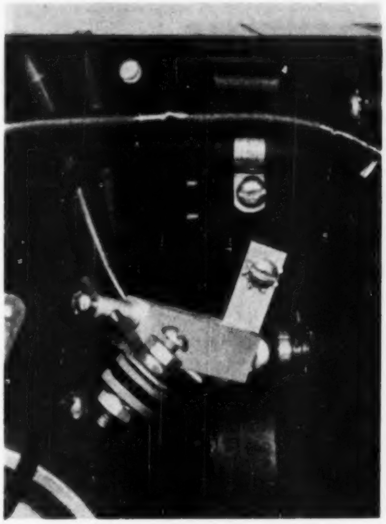


Fig. 6. Hum-canceling coil located on the main frame of the projector.

It is also possible to minimize the hum pickup at the disturbed points. Thus, a well-shielded input transformer is used and rotated for minimum hum pickup. All the low-level leads are tightly twisted and the layout of the switch wafers made to minimize open loops in the wiring. Ground loops are completely eliminated.

The residual hum is eliminated by the use of a hum-bucking coil (Fig. 6) in series with the record-play head. It was not possible to obtain a single minimum hum-bucking coil adjustment for the two conditions of projection lamp "on" and "off." However, a compromise coil position was found which gives satisfactory overall performance.

The performance of the electrical system may be summarized as follows: Since the output stage of the amplifier remains essentially unchanged, the power output rating is identical to that of the original amplifier. Also, overall charac-

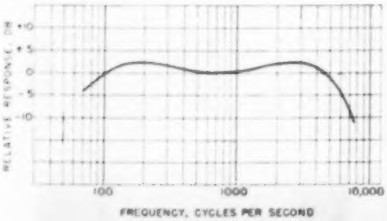


Fig. 7. Overall frequency response of the system for a signal recorded and played back.

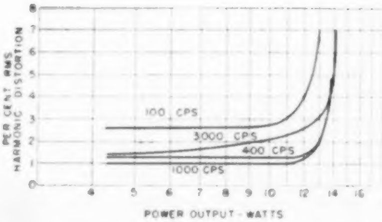


Fig. 8. Distortion curve of the amplifier.

teristics of the amplifier for optical playback and public address remain unchanged. During magnetic recording, it is possible to have 35-db attenuation in the volume control before the input stage overloads. The amplifier output networks are adjusted so that the amplifier distortion will always be small compared to that of the recorded signal. Thus, optimum signal-to-noise ratio is obtained during recording. With modulated film, the amplifier has approximately 15-db gain reserve during playback. Under these conditions, the signal-to-noise ratio is 50 db with the tone-control in the flat position. The overall frequency response (Fig. 7) of the system, for a signal recorded and played back on this projector, is flat within 5 db from 100 to 6000 cycles/sec.

The general specifications of the RCA 400 magnetic projector are given in Figs. 7 and 8 and in Table I. Figure 9 shows the complete unit.

The versatility of application of the basic development becomes apparent

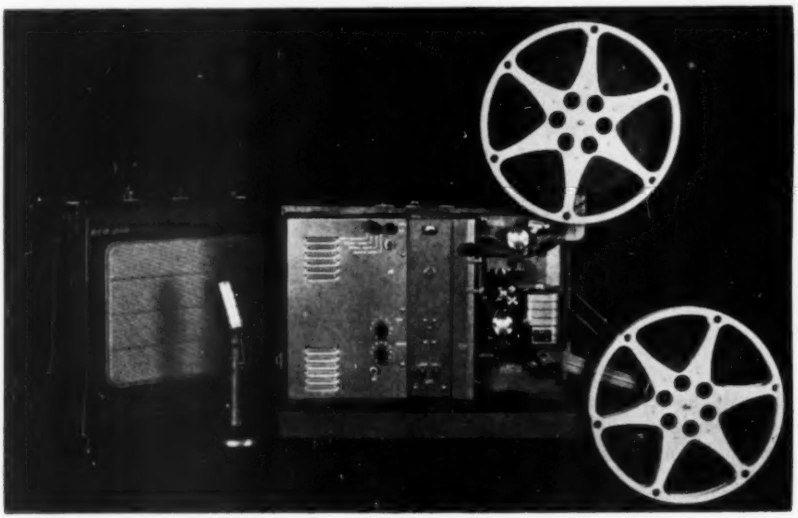


Fig. 9. The RCA-400 magnetic projector ready for operation.

Table I. Specifications of the RCA 400.

Amplifier power output (400 cycles, 5% distortion)	10 w	
Film speed (24 frames/sec)	7.2 in.	
Frequency response (magnetic)	100–7200 cycles	
Signal-to-noise ratio (magnetic)	50 db	
Input impedance	100,000 ohms	
Record-play head:		
Gap length	0.0005 in.	
Pole piece width	0.084 in.	
Inductance (1000 cycles)	3.4 mh	
Erase head:		
Gap length (double)	0.007 in.	
Pole piece width	0.125 in.	
Inductance (1000 cycles)	14.0 mh	
Exciter lamp frequency	50,000 cycles	
Cost of applying magnetic track to film (tentative)	3½ cents/ft	
	Projector	*Speaker*
Weight	45 lb	26 lb
Dimensions:		
Length	20½ in.	19⅝ in.
Width	9 in.	9 in.
Height	15 in.	15⅜ in.

with the enumeration of some of its potentialities. One particular advantage of magnetic recording is that the sound track is independent of the film emulsion or developing processes. The sound itself can be added either before or after the film has been developed for picture, resulting in great flexibility of editing. Lip synchronization can be obtained in a few trials.

Besides the conventional method of recording sound on a standard 100-mil track, some variations have been tested which present decided advantages for certain applications. For example, half of the width of an optically recorded track can be coated with iron oxide material. Although the output of both tracks is cut by 50% and their signal-to-noise ratio decreased, great practical advantages can be realized. For instance, the tremendous wealth of knowledge that has been accumulated in this country in instructional 16mm films can be released immediately to our friends overseas. They in turn can make their own translations and recordings at a very nominal cost per print. This is but one of the many possible applications of a 50/50 track.

Another variation that has been tried with success is the double-film system. This idea, it is believed, is the one for which the amateur has really been waiting. It consists simply of running through the projector two films, one being the old double-perforated film containing the picture, the other being a clear film carrying the magnetic track. This system offers all the desirable characteristics of a standard track, though a given reel size will accommodate only one-half the usual film length. This, of course, is insignificant considering the complicated arrangements that the more aggressive amateur is using today.

Another system which may have practical possibilities is that of edge-coating the old, double-perforated film. Though this method would be somewhat simpler to use than the one described above, it presents three disadvantages: (1) High amplitude variations are present in the recorded signal due to the proximity of the sound track to the sprocket holes. (2) The limited track width will result in an only moderate signal-to-noise ratio. (3) A specially positioned head would have to be provided for on the projector.

The cost of producing sound on 16mm film with this multi-use equipment has been estimated to be about one-third of the cost of achieving comparable results photographically. In addition, film waste due to recording errors is eliminated. Thus, small commercial studios, schools and colleges, sales and advertising organizations, governmental agencies, training specialists in medical, military, industrial, religious and law enforcement fields and especially the

amateur movie makers and photographers will benefit greatly by this development. To such users this new recorder-projector means high-quality sound, greater flexibility, and greater operating convenience with savings in time, film and processing costs.

References

1. Marvin Camras, "Magnetic sound for motion pictures," *Jour. SMPE, 48:* 14–28, Jan. 1947.

2. Marvin Camras, "Magnetic sound for 8-mm projection," *Jour. SMPE, 49:* 348–356, Oct. 1947.

Discussion

Loren L. Ryder: In the interest of standardization with respect to frequency characteristics, I wonder if you are in a position to make available the frequency characteristics of this recorder-reproducer at this time. It's quite possible that the work that you have done may set a pattern which should be followed. Further, it may be to the advantage of all if at an early date there is a semblance at least of standardization so that the product to be reproduced on your equipment or handled with other equipment might be interchangeable. Is that information available?

O. B. Gunby: Since the authors of this paper aren't here and detailed information on the frequency characteristic is not available in Hollywood at the present time, your question will have to be referred to them. However, I have a slide here that shows the frequency response used in making this demonstration film.

Lloyd Goldsmith: Again I'm speaking as chairman of the Sound Committee for the Society and I'd like to report that at our Tuesday morning meeting it was brought out that our Subcommittee on Magnetic Recording is attempting to standardize, or at least act as a clearing house, for information on the frequency response and the pre- and postequalization in these magnetic recorder-reproducer projectors for the benefit of all of the manufacturers. Accordingly, Glenn Dimmick has already circulated this information to the Subcommittee with respect to the RCA projector and I will be very glad to make it available to Mr. Ryder. Also, Ampro has indicated their division of pre- and postequalization, and I'm sure that before very long there will be agreement on recording-reproducing characteristics to allow complete interchange of magnetic film made on this type of projector.

Mr. Gunby: The slide is now ready for presentation. You will notice that it gives only the overall frequency response. It probably doesn't completely answer Mr. Ryder's question, but the information referred to by Mr. Goldsmith and which can be obtained from the Subcommittee on Magnetic Recording will likely provide the additional data requested.

Twin-Drum Film-Drive Filter System for Magnetic Recorder-Reproducer

By CARL E. HITTLE

Use of two drums in tight-loop type of film-drive filter system solves the problem of film support in magnetic recorder-reproducer utilizing two separate magnetic head assemblies. Performance of filter system is analyzed.

Many valuable contributions have been made to the art of sound recording by the design of film-drive mechanisms and a wealth of engineering principles covering these endeavors can be found in literature.[1] It might be considered, however, that many of the film-drive mechanisms described in the references were designed for specific applications using photographic film as the recording medium, and were not particularly suited for the magnetic type of medium. The theory of recording with the latter has established certain requirements for the film-drive mechanisms. These were met only with some degree of compromise with many of the other photographic-type drives employed in what might be referred to as the interim period for the acceptance of magnetic recording by the motion picture industry. Magnetic recording, having proven to be a useful tool, has dictated the need for a more comprehensive design of the overall equipment as well as of the system components. The purpose of this paper therefore is to describe a film-drive mechanism especially designed for magnetic recording and one which makes use of the many advantages attributed to the magnetic medium.

Features of the film-drive mechanism especially designed for magnetic recording may be more fully appreciated when illustrated against a background of those of the basically photographic types which were converted for use of magnetic film.

The conversion of a photographic-type recorder to magnetic is shown schematically in Fig. 1. In this instance, the photographic-type sound drum was foreshortened so that the portion of the magnetic film from the sound track location to the nearest outside edge of the magnetic film would extend beyond the drum much in the same fashion as would be required for converting to photographic sound reproducing. The single magnetic head was mounted so that the recording gap portion of the head would contact the coated surface of the magnetic film at the required location. The film-drive filter system of this recorder was a tight-loop system utilizing a magnetic drive

Presented on October 18, 1951, at the Society's Convention at Hollywood, by Carl E. Hittle, Radio Corporation of America, Engineering Products Dept., RCA Victor Div., 1560 N. Vine St., Hollywood 28, Calif.

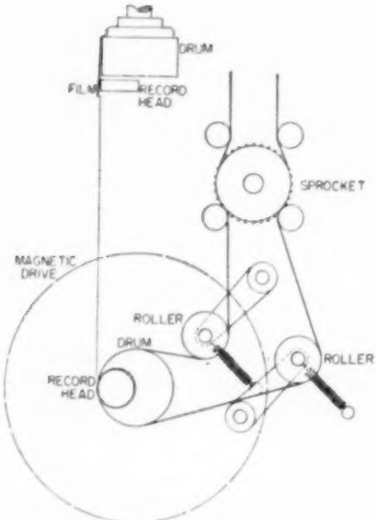


Fig. 1. Recorder having single magnetic head in drum.

for the sound drum as described by Collins.[1]

As may be observed from Fig. 1 since the coated surface of the film was toward the inside of the film loop between sprocket and drum, space limitations permitted the mounting of only the one magnetic head shown at the drum. In this particular adaptation the one head was used for recording the sound track and later for reproducing with no facilities available for monitoring the recorded track at the time of recording.

When used for photographic recording prior to the conversion, this equipment at least equalled any other commercially available equipment in providing flutter-free film motion. The quality of film motion, when used for magnetic recording, was for practical purposes the equivalent of that when used as a photographic recorder. However, experience with the equipment as a magnetic recorder indicated the need of a more desirable location for the magnetic head since head wear tended

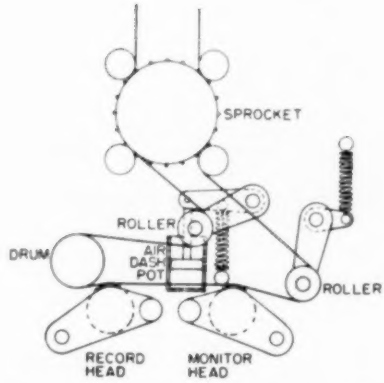


Fig. 2. Recorder having two retractable magnetic heads external from drum.

to be uneven due to difference in pressure between film and head across the width of the head. The partial view in Fig. 1 shows in exaggerated form the position the film tends to assume with respect to the head and drum. Necessarily, the head at the magnetic-gap section must protrude slightly beyond the film supporting surface of the drum to provide the desired contact pressure between film and head. Unit area pressure tends to be relatively high at the edge of the head adjacent to the drum and to diminish as the opposite edge is approached. This tendency may be reduced to some extent initially by a slight rotation of the head.

A second illustration of a basically photographic type of recorder modified for use of magnetic film is shown schematically in Fig. 2. The film-pulled drum type, tight-loop filter system with damping applied by means of a dashpot connected to one sprung roller arm was retained since it too provided excellent film motion. In this instance (as well as in the remainder of the systems to be described) the film threading was such that the coated surface faced to the outside of the film loop between sprocket and drum. With only a slight change in the film path,

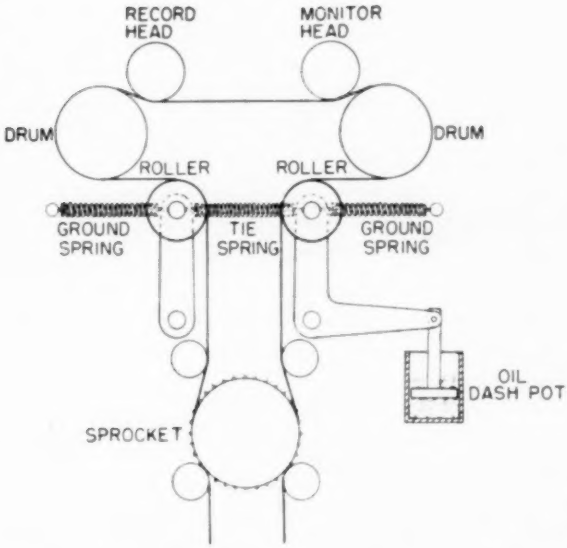


Fig. 3. Twin-drum recorder with drums in horizontal plane, single film sprocket.

space was made available for mounting both a record head and a monitor head. Since film motion tends to be of best quality at the sound drum or immediately following the drum with reference to direction of film travel, the record head was mounted adjacent to the drum on the film take-up side with the monitor head mounted as closely following as facilities would permit. The two head mountings were so designed that by actuation of detent pins the magnetic heads could be rotatably retracted from film contact position to eliminate possibility of abrasive damage to the film emulsion from head contact when using the equipment for photographic recording. This permitted almost immediate change-over from one recording method to the other.

One application of this equipment has been in television studios where double-film systems are used for making kinescope recordings of television programs. Operational economies are realizable due to the versatility of operation of this type of equipment. The purchase and use of such equipment becomes a money saving investment for television studios and others concerned with high-quality sound recording since either photographic or magnetic medium may be used for the original recording with magnetic recording available for making protection "takes" when two of these units are available.

Sound quality attainable with such equipment is at least as good with magnetic film as with photographic film. Reproduction using the record head is superior to that using the monitor head principally because of the better film motion obtainable at the record-head location. For this reason, the equipment is provided with switching facilities to permit the record head to function as a "playback" or reproducing head when best quality reproduction is desired.

Representative of the different approach used in designing a film-drive mechanism specifically for magnetic recording and reproducing is the mechanism shown schematically in Fig. 3. Since freedom of design permitted, an addition was made to the basic film-

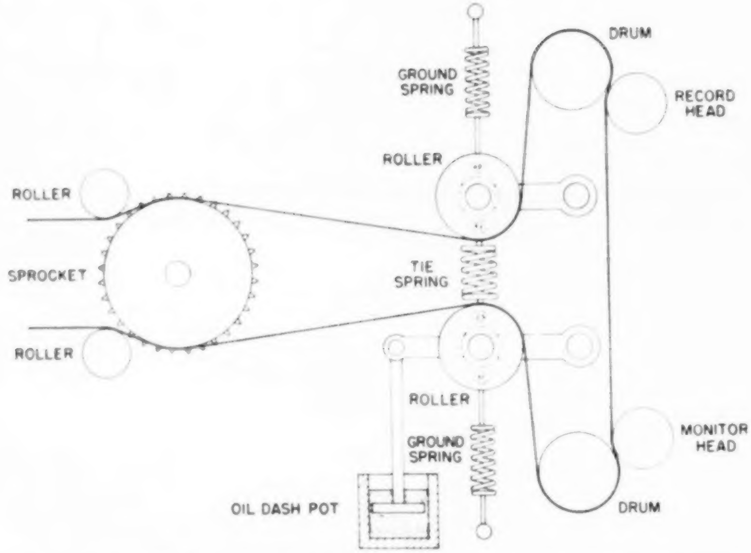


Fig. 4. Twin-drum recorder with drums in vertical plane, one film sprocket.

drive mechanism described in the last illustration given. This addition, made to provide film motion at the monitor head as nearly equal to that at the record head as possible, was a second impedance drum. The geometry of the film path, considering for the moment just the film sprocket and the two impedance drums, is basically an equilateral triangle in shape with the sprocket at the apex.

A sprung roller added to each of the two equal sides of the basic triangle serves two purposes. Each serves to alter the film path in such a manner as to increase the film wrap about its adjacent drum to the degree desired for film-pulled drum operation. The two sprung roller arm assemblies with associated tie spring are also essential elements in the twin-drum film-drive filter system. The relatively light sprung roller arms tend to absorb any disturbances introduced into the film motion through the film-drive mechanism. This results from the fact that the film is held in tight contact with the rotating drum surface and the much greater inertia effects of the rotating flywheel mass of the impedance drums make these elements relatively insensitive to such film motion disturbances. Damping of any tendencies of the sprung roller arms and the drums to oscillate is provided by the oil-type dashpot which is linked mechanically to one of the sprung arms. The oil used in the dashpot is a selected grade of temperature-stable silicone.

Film tensioning is furnished through the force exerted by the tie or center spring connected to the two sprung or tensioning arms when the film is threaded properly in the film path shown. Ground springs shown in the illustration are used principally for mechanical purposes and have little effect as functional members of the filter system. Without the ground springs, the sprung roller arms tend to rotate to one or the other extremity of their arc of travel, depending on direction of film motion.

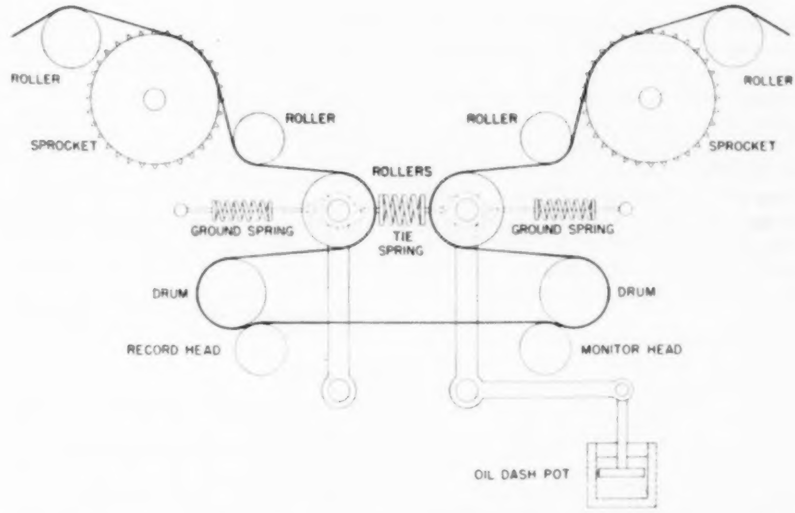


Fig. 5. Twin-drum recorder with drums in horizontal plane, two film sprockets.

Performance has justified the departure from the usual photographic-type film path to that which has just been described utilizing the two impedance drums. Flutter content of a recording reproduced by the record head is less than 0.1% rms total with less than 0.05% rms being 96-cycle flutter.[2] Flutter content using the monitor head for reproducing is less than 0.15% rms total with less than 0.05% rms being 96-cycle flutter.

It might be well at this point to mention two features relative to the use of the twin-drum assemblies. From outside our organization has come the suggestion that the inertia effect of the two impedance drums would have to differ by appreciable amounts to permit satisfactory performance free of beat-frequency disturbances from the two drums having equal size and weight. Our experience indicates through the consistent low flutter performance obtained that drum assemblies of equal inertia effect are satisfactory in the filter system which we are now using. The second feature relates to the position of the magnetic head with respect to drum to provide optimum film motion performance. Tests were made to determine if head position had the same relative effect on observed flutter as compared with that of single-drum magnetic recorders. These tests showed that head location with respect to drum along the path of the tensioned film between the two drums had no bearing on the quality of film motion. Since a latitude of choice of head location existed, locations for the record and monitor heads were chosen which permitted maximum useful head life to be obtained with the original factory head setting. These locations also provided protection for the heads at their most critical section, the film contact area at the magnetic gap, due to the close proximity of this area to the drum.

The mechanism shown in Fig. 4 is the basic mechanism of Fig. 3 rotated 90° with the dashpot appropriately relocated and is intended primarily for standard relay cabinet rack mounting

as part of a permanent magnetic recording system in studios. Equipments produced to date using the physical arrangement of components as shown have been of the triple-track type, as described by Singer and Pettus.[3] (It is equally adaptable for single-track magnetic equipments.) Quality of film motion even though six magnetic heads are in contact with the film simultaneously is equally as good as with the single-track equipment represented by Fig. 3.

Further illustration of the way in which the basic design of the twin-drum film-drive filter system has been adapted to meet varying space needs is shown in Fig. 5. In this instance, design requirements of compactness without sacrifice of quality of performance had to be met. Use of the second sprocket facilitated the attainment of both size and weight reduction. As may be seen by comparing Fig. 5 and Fig. 3, the filter system is essentially the same in the two illustrations. Film motion using the mechanism shown in Fig. 5 has proven to be equally as good as that described for the mechanisms of Figs. 3 and 4. Equipment utilizing the film-drive mechanism shown in Fig. 5 is described in the paper by Singer and Ward immediately following in this *Journal*.

The drum shaft assembly, sprung or tension roller assembly, and sprocket assembly of the twin-drum film-drive filter system remain essentially unchanged throughout the variations of the system previously described. The same basic filter system is used on 35mm, 17½mm and 16mm equipments.

Field performance has furnished proof of the soundness of design of the twin-drum film-drive filter system, adequate solution of the problem of film support in the critical region of the magnetic head, and the advantageous choice of magnetic head locations.

References

1. M. E. Collins, "A deluxe film recording machine," *Jour. SMPE, 48:* 148–156, Feb. 1947; "Lightweight recorders for 35- and 16-mm film," *ibid., 49:* 415–424, Nov. 1947.
2. Proposed American Standard, Z57.1/68, Method for Determining Flutter Content of Sound Recorders and Reproducers, American Standards Assn., 70 E. 45 St., New York City.
3. Kurt Singer and J. L. Pettus, "A building-block approach to magnetic recording equipment design," scheduled for publication soon in the *Journal*.

Discussion

D. J. White: The thing that I found most interesting about this discussion of the dual drum filter mechanism was the reference that the speaker made to the "outside" sources who had called the attention of the industry to the fact that different inertias and different masses in the two inertia wheels make a definite and distinct difference in the characteristics of motion. As the originators of the dual flywheel motion path, we at Magnagram feel that we are somewhat qualified to make the statement that our experience has proved there is definitely a difference when the proper ratio between the two inertia wheels is achieved.

The first machine, which we introduced in May of 1948 to the Society's 63rd Semiannual Convention, employed dual inertia wheels of the character just described by the Speaker. Since that time, we've conducted numerous experiments and we have determined conclusively that we can reduce overall low-frequency modulation by making calculated changes in the mass and inertia of the two flywheels. For your information we refer to this as "Synkinetic" motion.

Carl E. Hittle: As mentioned during the reading of the paper, we can speak only from the experience which we have had with our type of system and I can only reiterate the fact that, in the relatively few years that we have been playing with this type of equipment, we have not encountered any difficulty due to the fact that our flywheels are of equal mass.

A Technical Solution of Magnetic Recording Cost Reduction

By KURT SINGER and H. CONNELL WARD

This new portable magnetic recording channel, designed primarily for 17½ mm film provides high-quality operation and all of the needed facilities for production recording. By operating at 45 fpm a considerable economy in film cost is realized and the size and weight of the recorder are reduced. The recorder is also adaptable for 16mm or 35mm film. A new amplifier system utilizing miniature tubes and small components is provided as part of the equipment.

On May 18, 1948, the first studio-type magnetic recording channel was described at this Society's Convention at Santa Monica, Calif.[1]; and, on October 27 of the same year the first portable magnetic recording equipment was presented at the Society's Convention at Washington, D.C.[2] Both of them used perforated 35mm magnetic film. Their demonstrations gave convincing proof that synchronous magnetic recording was a useful tool in the production of sound motion pictures.

These equipments were produced by the addition of the magnetic recording elements to existing photographic recording facilities, and, in some cases, the modified equipments were capable of using both photographic and magnetic film as the recording media. With a number of modified channels in service, information was obtained concerning the features and facilities that should be included in an equipment designed for magnetic recording only. The first of these was the PM-62 portable system. Shortly afterwards, the PM-63 and PM-66 rack-type arrangements were made for triple-track and single-track recording. These are described in detail in a paper entitled, "A Building-Block Approach to Magnetic Recording Equipment Design" by Kurt Singer and J. L. Pettus (to be published soon in the *Journal*).

Despite the accomplishments of these channels, many have felt that the anticipated saving was not sufficient to warrant converting to magnetic recording. There has also been the need for smaller, lighter-weight magnetic recording facilities capable of recording continuously a 30-min program for television applications. By previous standards, it would

Presented on October 18, 1951, at the Society's Convention at Hollywood, Calif., by Kurt Singer and H. Connell Ward, Radio Corporation of America, RCA Victor Div., Engineering Products Dept., 1560 N. Vine St., Hollywood 28, Calif.

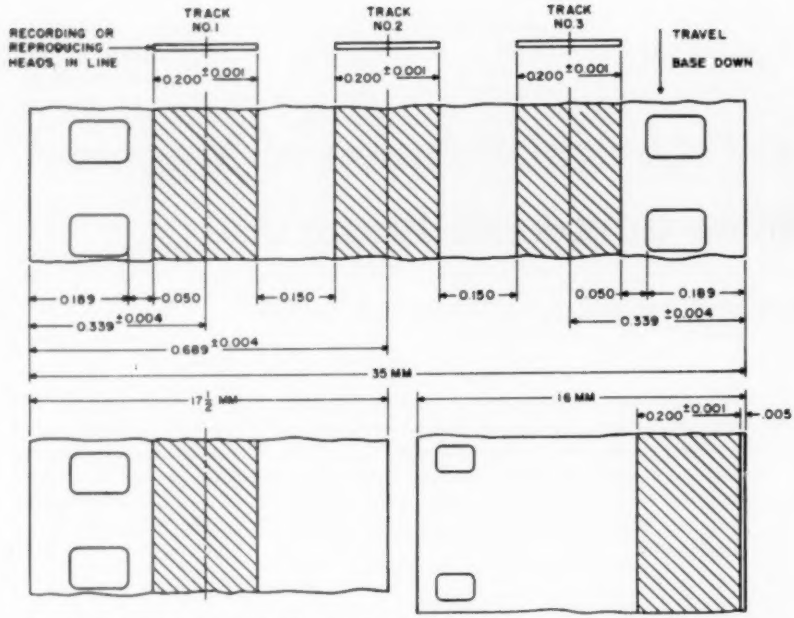


Fig. 1. Proposed magnetic film track standards for 35mm, 17½mm and 16mm.

be necessary for the recorder to use 3000-ft film reels for television and 1000-ft reels for location purposes. From additional investigations grew the idea of split 35mm film operating at "split" 35mm speed or 45 fpm for all original recording. The use of split 35mm film had already gained acceptance as evidenced by the 17½mm magnetic track location proposed by the Motion Picture Research Council[3] and later appearing as a proposed American standard.[4] Tests showed that 45 fpm provided a reasonable reserve in frequency range over that normally used in sound motion picture production and the ratio between this new speed and the standard speed for release film was made very simple. By splitting a 1000-ft roll of 35mm film which has a recording time of approximately 11 min at 90 fpm into two rolls and cutting it into 500-ft lengths, we have 44 min of recording time at 45 fpm. This automatically gives a film cost saving of 75% and approximately the same amount of saving in film storage space. In addition, the reduction in the initial film capacity represented a considerable reduction of recorder weight and volume.

As companion unit for this new magnetic recorder, a new amplifier system capable of being operated from either of two types of power supplies has been designed.

The above reviews briefly the steps leading up to the RCA PM-64 Portable Magnetic Recording Equipment which will be described in detail below.

Equipment Features and Adaptations

Many combinations of film width and speeds, motor systems and power supplies are available. For 35mm and 17½ mm width, recording speeds of 90 fpm or 45 fpm are available. For 16mm, a speed of 36 fpm is employed. Any of the

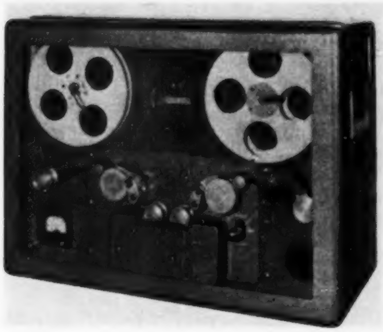


Fig. 2. PR-42 Portable Magnetic Recorder, 17½mm equipped with 500-ft reels.

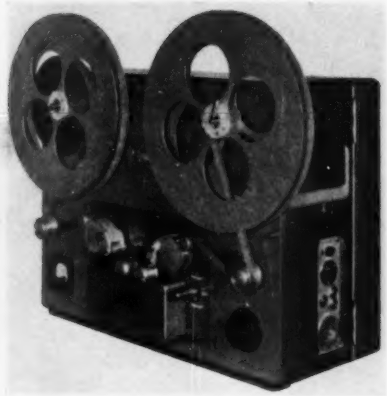


Fig. 3. PR-42 Portable Magnetic Recorder, 17½mm equipped with 1500-ft reels, covers removed.

commonly used motor systems may be used with any combination of film width and speed.

This equipment adheres to the proposed American standard for track locations (Fig. 1).

The associated audio amplifiers meet the established studio requirements for high-grade recording systems. High-level mixing is provided for two microphones with four steps of dialogue equalization. The mixer may use either direct or magnetic monitoring and facilities are available for him to communicate with the recordist or boom man. The system may be operated from a-c mains or storage batteries.

Recorder Structure

The recorder as seen in Fig. 2 has three basic parts: the front cover, the rear cover and the center section. A large plastic window in the front cover permits film observations while 500-ft reels are in use and the cover closed. By loosening two thumbscrews, the front cover can be removed to permit the use of film reels larger than 500 ft. The rear cover is similar to the front cover. Located inside its back is a mounting for additional belts and sound-absorptive material for noise control. The center section of the case is a cast magnesium box having an open end. The closed or front end forms the panel for mounting the drive, take-up and feed mechanisms, footage counter and electrical components associated with the bias oscillator and playback amplifier. At either end are panels containing additional components for external electrical connections and controls (Fig. 3). This arrangement facilitates the adaptability of the recorder to different motor systems, control circuits and external electrical connections and allows the recorder to be operated completely enclosed.

The recorder may be modified for operation with 1500-ft instead of 500-ft reels in about 8 min by removing the three thumbscrews which mount the take-up and feed mechanisms and by remounting that mechanism in its new location (see Fig. 4). Except for belts, all items integral to this change are part of the recorder.

For transportation, two flush-type handles are attached to the ends of the center section.

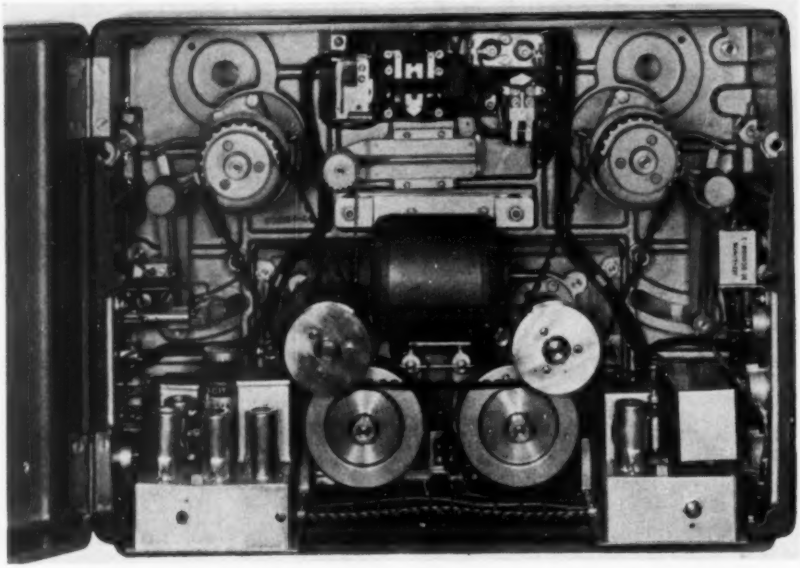


Fig. 4. PR-42 Portable Magnetic Recorder, rear cover opened.

Fig. 5. PR-42 Film-Drive Mechanism, front view.

Drive Mechanism

The basic element of the drive mechanism is a mounting plate that contains the drive motor, mechanical filter system, magnetic heads, motor controls, guide rollers and other items integral to its operation. The mounting plate, as seen in Fig. 5, is a cast magnesium panel capable of being mounted for either portable or studio applications. The drive mechanism, using magnesium for all cast parts, has an overall weight of approximately 26 lb.

The drive motor is one of a new series of motors especially designed for magnetic recording equipment. The motor, which is mounted to the rear of the mechanism plate, contains a precision gear reduction unit to allow the drive sprocket to be coupled directly to the output shaft. Also coupled to the shaft, but extending to the rear, is an overrunning clutch assembly with driving media for the holdback sprocket, the take-up mechanism and the footage counter. Interchangeable gear reduction units provide for ratios varying between 10:1 and 125:9, depending upon the film speeds required and the type of motors used.

The film drive consists of two 32-tooth sprockets in a symmetrical path which includes two tension or filter rollers and two drum assemblies. Located in the film path, between the drums, are the magnetic record and monitor head assemblies. The film drive is described in detail in the paper "Twin-Drum Film-Drive Filter System for Magnetic Recorder-Reproducer" by Carl E. Hittle, immediately preceding this paper in this *Journal*.

A combination drive and holdback sprocket[5] was designed to replace the standard sprocket because it best fulfills the needs of the tight-loop system and will allow the recorder to be operated in either direction without sprocket changes. The sprocket pitch and tooth shape are dimensioned so that the face of only one tooth is driving or holding back the film at any given time. The sprocket will accommodate films with 0.6% shrinkage and 0.02% expansion. The area of contact between film and sprocket has been reduced from 90° in the earlier sprocket to 60° maximum for the new sprocket.

The tension or filter rollers are mounted on shafts attached to the ends of the roller arms. These arms are in turn pivoted from a fixed point. The arms are tied together by a spring and are separately grounded by additional springs. Figure 6 shows the mechanical filter system schematic. An oil-type dashpot is attached to the other end of the right roller arm by suitable linkages. The damping medium is a selected grade of silicone oil. The entire system is near critically damped with a resonant frequency of 1½ cycle/sec.

The drum assemblies, mounted in cast tubular housings identical with those of the holdback sprocket, have dynamically and statically balanced flywheels serving as inertia elements. Both drums are film driven.

The magnetic head[6] may be used for either single- or multiple-track applications. For single-track applications, there is a two-piece holder having a ball-and-socket type of anchorage. Through the mounting flange screws, the anchorage and four opposing setscrews bearing on the head, it is possible to give longitudinal, lateral and transverse adjustments[7] to the head as required. For 16mm and 35mm operations, a hardened stainless-steel shoe is placed in alignment with the magnetic heads, thereby maintaining an even plane of film across the magnetic head and an even pressure at the gap, thus minimizing wear. For 17½mm operation, the magnetic head is only 5½ mils from the center line of the film. Instead of using a shoe, the drums are tapered and flanged allowing the film to be guided from the perforated edge, thus assuring track location, uniform contact and minimum wear.

The motor-control-switch mechanism

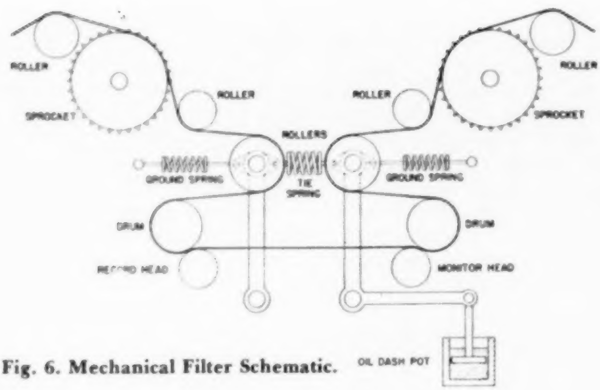


Fig. 6. Mechanical Filter Schematic.

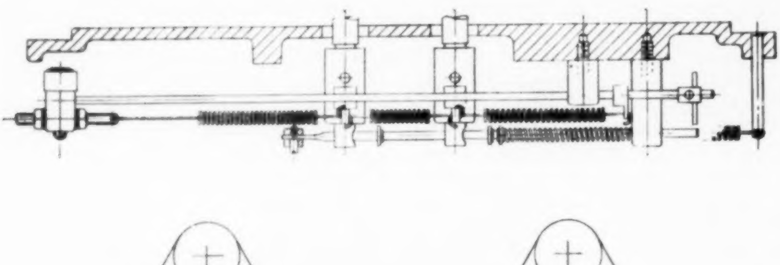


Fig. 7. PR-42 Film-Drive Mechanism with motor and flywheels removed.

is used for switching and for adjustments of the ground springs connected to the filter roller arms. Referring to Fig. 7, it may be seen that the filter ground springs have been arranged so that they are automatically tensioned through a bell-crank arrangement for the respective running directions of the mechanism. The damped filter roller ground spring is connected to the bell crank by an adjustable anchorage which permits quick adjustment of the filter roller balance. The undamped filter roller spring likewise has an adjustable anchorage, but is used for manufacturing convenience only. The center tie spring is permanently attached to the filter roller arms. The mechanical linkage, on which the undamped adjustable anchorage is mounted, also carries fingers that actuate microswitches that in turn control remotely mounted relays in the motor circuit. The motor-control switch consists of a bar moving vertically in an elongated slot. It is positively locked in the "off" position and released by pushing in on the bar to either of the operating positions.

The sprocket shoes are basically safety devices, since the film has a mechanically predetermined amount of wrap on each sprocket. Both shoes are held for normal clearance from the sprocket by a positive locking detent arrangement and spring tension. The drive sprocket shoe (Fig. 7) is mechanically linked with the filter rollers in such a fashion that when it is opened, the undamped filter roller is locked in its rest or innermost position and the damped filter roller is displaced from its rest position to a predetermined location. The film may then be threaded through the film-drive system in tight fashion. Upon releasing the drive-sprocket shoe, the filter rollers are freed to their normal positions and the film loop is thus automatically formed.

High permeability shielding around the motor and the magnetic heads is used to prevent hum pickup. Ball bearings have been used at all points except on the motor shafts.

Take-up and Feed Mechanisms

It has long been the desire of all associated with the motion picture industry to acquire an efficient mechanical take-up and feed mechanism. As a result, the take-up and feed mechanisms were designed with constant torque to guard against their failure during the operating cycle of a roll of film. Tests showed that with constant torque the film tension between the film reels and the take-up or holdback sprockets varied by ratios of 7:1 or 1:7, respectively, throughout the length of a 1500-ft roll of film wound on a 2-in. core. By varying the applied torque at the friction-clutch assembly in the new take-up and feed mechanisms (Fig. 8), it is possible to have near-constant film tensioning between the film reels and sprockets. Tests using a 1500-ft roll of film on a 2-in. core indicated that the tension varied only 2 oz throughout the length of the film roll.

The take-up and feed mechanisms are composed of identical subassemblies; therefore the mechanical construction will be discussed in terms of the take-up. The take-up is driven through an overrunning clutch mechanism located at the friction-clutch assembly, a precision rubber cog belt and a clutch mechanism coupled to the rear extension of the output shaft. For varying the amount of pressure needed during operation, suitable mechanical linkages are used to connect the adjustable compression spring to an extended portion of the sensing roller arm. This connection allows the spring compression to vary as required by the film pull on the sensing roller.

The decreasing weight of the film reel causes a small amount of overslipping at the friction-clutch assembly, since the pressure of the compression spring at a given instant is not sufficient to assure take-up of the film. At this given instant, the sensing roller relaxes its position in the slot to equal the slacking of the tension in the film loop from sprocket to take-up reel.

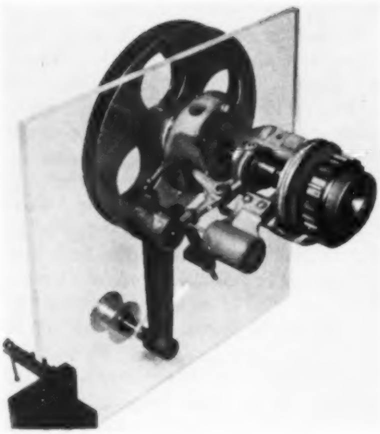


Fig. 8. Take-up Assembly, parts arrangement.

Fig. 9. MI-10278 Mixer Amplifier Case.

Fig. 10. MI-10278 Mixer Amplifier Case on Pedestal.

Fig. 11. MI-10278 Mixer Amplifier Case (internal arrangement).

By this action the sensing roller, through its linkages to the compression spring, causes the spring to be compressed, thus giving the needed additional pressure at the friction-clutch assembly. These minute impulses are continuous throughout the time required to transport the film through the recorder.

Also attached to the extended portion of the sensing roller arm is a spring with an adjustable anchorage and a dashpot. The dashpot softens the shock of the roller arm when the roller moves toward either of the extremities of the slot at starting or stopping, or in case of irregularities in the film loop. The dashpot also keeps the sensing roller from hunting

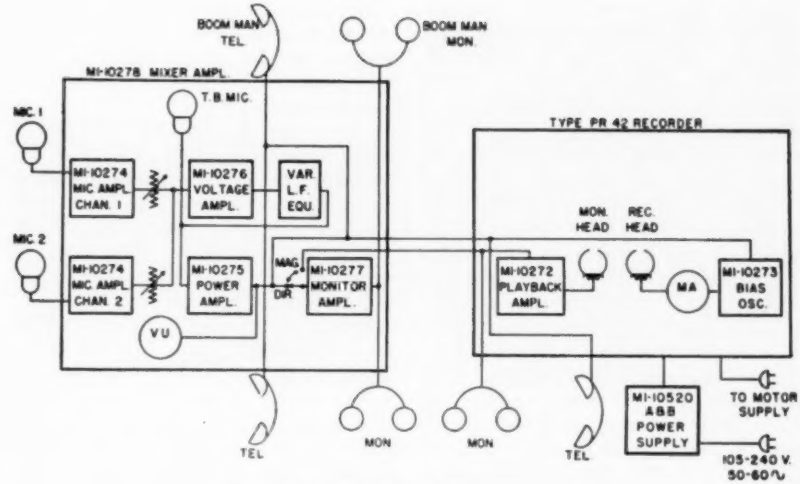


Fig. 12. Transmission Block Schematic.

during the normal operation of the recorder.

As a result of this arrangement, the film tensions between feed reel, holdback sprocket, take-up reel and drive sprocket are near constant at all times. Also, through the action of the overrunning clutch mechanisms, the operation of take-up and feed mechanism may be reversed according to the rotational action of the drive motor.

All recording amplifiers and recording control circuits are contained in the mixer amplifier case shown in Fig. 9, in the closed position ready for transportation. For operation, the top cover is removed and a writing surface attached to a hinge, normally located inside the cover, is folded to the right side of the case. This permits the mixer to keep his log and facilitates his written entries. On the left side is a hinged bracket which furnishes support for a sound-powered telephone set. The mixer case, ready for operation and on a collapsible pedestal, is shown in Fig. 10.

The internal arrangement of amplifiers and control panel is shown in Fig. 11. Plug-in amplifiers are used throughout, for maximum serviceability.

The electrical transmission circuit conforms to the block diagram shown in Fig. 12. The signal from two microphones is amplified by separate microphone amplifiers whose output is controlled by individual mixer pots, then combined and further amplified by means of a voltage amplifier. The signal is then conducted to the power amplifier, and hence directed to the recorder. The case containing the above-described amplifiers also contains a monitor amplifier whose input is normally bridged across the output of the recording amplifier. At the recorder the signal is combined with the bias current and fed to the recording head. In the recorder itself are contained a bias oscillator and a playback amplifier. The output from this playback amplifier is brought back to the amplifier case and is available to the mixer by pressing a button so it can be compared with the output from the direct monitor. All amplifiers located in the mixer amplifier case use the same tube type, namely, 12AY7. Only three

different tube types are used in the entire channel, each chosen to insure optimum operating efficiency and freedom from microphonics and tube noise. For instance, the two lowest-level stages in the playback amplifier employ RCA 5879 tubes which are selected to be equal in noise to RCA-1620's. In the bias oscillator the tube is a 12AU7 which has worked out very satisfactorily in previous similar applications.

Let us consider briefly the circuits of each amplifier. The microphone amplifiers each use one single 12AY7 tube. The two triode sections of these tubes are connected in cascade with sufficient feedback from input to output to keep distortion to a minimum and to stabilize the gain, so that changes in tube characteristics and component tolerances have only a negligible influence on the gain or frequency characteristic. The microphone amplifier input transformers provide facilities for working from 30-, 50-, 150- or 250-ohm microphones. These transformers have been especially designed so that one primary connection permits the interchangeable use of 30- or 50-ohm microphones, whereas another connection accommodates 150- or 250-ohm microphones. The change in frequency characteristic when working from these various impedances is negligible. Means are also incorporated in the microphone amplifiers to reduce the gain by 10 db if high-level pickup conditions should make this necessary. A toggle switch introduces equalization so that either velocity or pressure microphones can be used satisfactorily.

The voltage amplifier uses one 12AY7 tube connected in similar fashion as already described in the microphone amplifier. It also contains a switch for 10-db gain reduction which is normally in the circuit so that a reserve gain of 10 db is available should it be required. In addition to the amplifier circuit itself, there are also provided an 8000-cycle low-pass filter and a low-frequency boost circuit. The voltage amplifier chassis also contains a 400-cycle RC oscillator which may be used for system lineup purposes and for the recording of a reference tone for level adjustment of the transfer channel.

The power and monitor amplifiers employ identical circuits, except that a gain control potentiometer is added in the monitor amplifier and different secondary impedances are available at the output transformers. Three 12AY7 tubes are used to provide the necessary gain and power handling capacity. The output stage is a push-pull stage fed from a conventional phase splitter. The phase splitter is directly coupled to a driver stage. Negative feedback by means of a tertiary winding on the output transformer is applied to the driver stage cathode. An additional 12AY7 tube furnishes voltage gain employing a circuit similar to the microphone amplifier.

These five amplifiers are all housed together in an aluminum case (Fig. 10), the top surface of which contains all control facilities such as VU meters, mixer pots, power supply voltage metering switch, oscillator on-and-off switch, magnetic-direct monitoring switch and four steps of dialogue equalization. In addition, a pair of jacks has been provided for monitoring headsets of either 10- or 50-ohm impedance. A separate telephone circuit permits communication with the recordist and/or boom man. A talkback microphone is available to the mixer for slating and directions to the recordist and boom man during rehearsals. A pair of headset jacks has also been provided for a monitoring headset for the boom man.

As indicated before, the recorder itself contains a magnetic monitoring or playback amplifier and a bias oscillator. Two 5879 tubes and two 12AY7 tubes are used in the playback amplifier. The push-pull output stage is supplied by a conventional phase splitter which in turn is fed by a driver stage. Negative feedback from the output to the driver stage cathode is obtained by means of a

Fig. 13. MI-10520 Power Supply.

Fig. 14. MI-10520 Power Supply.

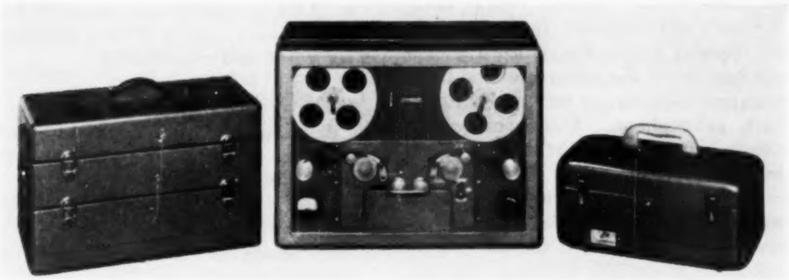


Fig. 15. Overall Channel.

tertiary winding on the output transformer. Two 5879 tubes are used in the first and second stage and stabilized with negative feedback from second stage output to first stage cathode. A gain control is located after the second 5879 tube. The magnetic reproducing head is connected to this amplifier through a special input transformer. The output of this amplifier is available at a pair of jacks for headset monitoring and also brought back to the mixer amplifier for magnetic monitoring at the disposal of the mixer. An equalizer circuit located within the amplifier provides an overall recording/reproducing frequency response virtually flat from 40 to 8000 cycles. The equalizer constants can be changed to take care of film speeds of 90, 45 or 36 fpm.

The bias oscillator utilizes a single 12AU7 tube and furnishes more than sufficient bias current for all presently manufactured magnetic emulsions. A meter which indicates bias current and which uses a germanium rectifier bridge circuit is mounted in the recorder front panel for convenient observation by the recordist. A bias control which normally needs no resetting has been located on the oscillator chassis itself and is available after opening of the recorder back cover. The application of bias to the record head is controlled by a 3-position switch located on the recorder

front panel. In the "play" and "off" positions no bias is applied to the record head, whereas in the "record" position, up to 20 ma of bias current are available. The bias oscillator chassis also contains a relay which is actuated whenever the bias current is turned off as, for instance, during rehearsals or playback or when the recorder is operated backwards. It also disconnects the oscillator from the output of the recording amplifier and provides the proper termination. This has been done as a precautionary measure in order to avoid accidental contamination of a recording. A separate relay transfers the recordist's monitor headset from the output of the playback amplifier to the recording line which normally supplies signal to the bias oscillator. This transfer takes place automatically whenever the recorder is not running so that the recordist always can hear when the mixer wants to communicate with him by means of the talk-back microphone. This arrangement also permits the recordist to listen to rehearsals.

Two 6-conductor cables are used between the mixer amplifier and the recorder. These cables contain signal transmission circuits, telephone circuits, buzzer circuits and power circuits. A separate cable is needed between the recorder and the power supply.

Two types of power supplies are provided. An a-c power supply furnishes d-c heater current and load and line regulated B current (Figs. 13 and 14). In addition, a dynamotor supply will be available shortly which will permit the use of storage batteries for location work and will work in conjunction with the multiduty motor setup.

The weight of the mixer case complete with amplifiers and tubes and cover is 31 lb. The weight of the recorder with playback amplifier, bias oscillator, front and back cover is 76 lb, and the a-c power supply weighs 29 lb. All three units comprising the entire channel are shown in Fig. 15.

Summary

While this recording channel does not represent minimum weight and size facilities, it offers studio quality performance and provides among many others the conveniences listed below which normally would have to be sacrificed to reduce weight and bulk.

1. Versatility of film speeds and film widths, namely, speeds of 90, 45 or 36 fpm; film widths of 35, 17½ or 16mm.
2. Flexibility of drive motors:
    a. single-phase, 115-v a-c, 50 and 60 cycles,
    b. 3-phase, 220-v a-c, 50-, 60-cycle,
    c. multiduty motor which permits operation from 96-v storage battery or 208/230-v a-c, and
    d. selsyn interlock.
3. One to three tracks.
4. Forward and/or reverse direction of recording and reproducing.
5. Tight loop threading.
6. Overall recording and reproducing signal-to-noise ratio between 55 and 60 db can be obtained consistently at distortion of 2.5%.

References

1. Earl Masterson "35-mm magnetic recording system," *Jour. SMPE, 51:* 481–488, Nov. 1948.
2. O. B. Gunby, "Portable magnetic recording system," *Jour. SMPE, 52:* 613–618, June 1949.
3. Motion Picture Research Council Recommendation 58.301-B.
4. Proposed American Standard, Dimensions for Magnetic Sound Tracks on 35 mm and 17½ mm Motion Picture Film (First Draft), PH22.86, *Jour. SMPTE, 57:*72, July 1951.
5. J. S. Chandler, "Some theoretical considerations in the design of sprocket for continuous film movement," *Jour. SMPE, 37:* 164–176, Aug. 1941.
6. M. Rettinger, "A magnetic record-reproduce head," *Jour. SMPTE, 55:* 377–390, Oct. 1950.
7. Terms are those defined by N. M. Haynes, "Magnetic tape and head alignments nomenclature," *Audio Eng., 33:* 22, June 1949.

Constitution of the Society of Motion Picture and Television Engineers

ARTICLE I

Name

The name of this association shall be SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS.

ARTICLE II

Objects

Its objects shall be: Advancement in the theory and practice of engineering in motion pictures, television, and the allied arts and sciences; the standardization of equipment and practices employed therein; the maintenance of a high professional standing among its members; and the dissemination of scientific knowledge by publication.

ARTICLE III

Meetings

There shall be an annual meeting and such other regular and special meetings as provided in the Bylaws.

ARTICLE IV

Eligibility for Membership

Any person of good character is eligible to become a member in any grade for which he is qualified in accordance with the Bylaws.

ARTICLE V

Officers

The officers of the Society shall be a President, an Executive Vice-President, a Past-President, an Engineering Vice-President, an Editorial Vice-President, a Financial Vice-President, a Convention Vice-President, a Secretary, and a Treasurer.

The term of office of all elected officers shall be for a period of two years.

The President shall not be eligible to succeed himself in office.

At the conclusion of his term of office the President automatically becomes Past-President.

Under conditions as set forth in the Bylaws, the office of Executive Vice-President may be vacated before the expiration of his term.

A vacancy in any office shall be filled for the unexpired portion of the term in accordance with the Bylaws.

ARTICLE VI

Sections

Sections may be established in accordance with the Bylaws.

ARTICLE VII

Board of Governors

The Board of Governors shall consist of the President, the Past-President, the five Vice-Presidents, the Secretary, the Treasurer, the Section Chairmen, and twelve elected Governors. An equal number of these elected Governors shall reside within the areas included in the Eastern time zone; the Central time zone; and the Pacific and Mountain time zones. The term of office of all elected Governors shall be for a period of two years.

ARTICLE VIII

Amendments

This Constitution may be amended as follows: Amendments may originate as recommendations within the Board of Governors, or as a proposal to the Board of Governors, by any ten members of voting grade; when approved by the Board of Governors as set forth in the Bylaws, the proposed amendment shall then be submitted for discussion at the annual meeting or at a regular or special meeting called as provided in the Bylaws. The proposed amendment, together with the discussion thereon, shall then be promptly submitted by mail to all members qualified to vote, as set forth in the Bylaws. Voting shall be by letter ballot mailed with the proposed amendment and discussion to the voting membership. In order to be counted, returned ballots must be received within sixty (60) days of the mailing-out date. An affirmative vote of two thirds of the valid ballots returned, subject to the above time limitations, shall be required to carry the amendment, provided one fifteenth of the duly qualified members shall have voted within the time limit specified herein.

BYLAWS OF THE SOCIETY OF MOTION PICTURE AND TELEVISION ENGINEERS

BYLAW I

Membership

Sec. 1. Membership of the Society shall consist of the following grades: Honorary members, Sustaining members, Fellows, Active members, Associate members and Student members.

An *Honorary member* is one who has performed eminent service in the advancement of engineering in motion pictures, television, or allied arts. An Honorary member shall be entitled to vote and to hold any office in the Society.

A *Sustaining member* is an individual, company, or corporation subscribing substantially to the financial support of the Society.

A *Fellow* is one who shall be not less than thirty years of age and who shall by his proficiency and contributions have attained to an outstanding rank among engineers or executives of the motion picture or television industries. A Fellow shall be entitled to vote and to hold any office in the Society.

An *Active member* is one who shall be not less than twenty-five years of age and shall be or shall have been either one or an equivalent combination of the following:

(a) An engineer or scientist in motion picture, television or allied arts. As such he shall have performed and taken responsibility for important engineering or scientific work in these arts and shall have been in the active practice of his profession for at least three years, or

(b) A teacher of motion picture, television or allied subjects for at least six years in a school of recognized standing in which he shall have been conducting a major course in at least one of such fields, or

(c) A person who by invention or by contribution to the advancement of engineering or science in motion picture, television or allied arts, or to the technical literature thereof, has attained a standing equivalent to that required for Active membership in (a), or

(d) An executive who for at least three years has had under his direction important engineering or responsible work in the motion picture, television or allied industries and who is qualified for direct supervision of the technical or scientific features of such activities. An Active member shall be entitled to vote and to hold any office in the Society.

An *Associate member* is one who shall be not less than eighteen years of age, and shall be a person who is interested in the study of motion picture or television technical problems or connected with the application of them. An Associate member is not privileged to vote, to hold office or to act as chairman of any committee, although he may serve upon any committee to which he may be appointed; and, when so appointed, shall be entitled to the full voting privileges on action taken by the committee.

A *Student member* is any person registered as a student, graduate or undergraduate, in a college, university, or other educational institution of like scholastic standing, who evidences interest in motion picture or television technology. Membership in this grade shall not extend more than one year beyond the termination of the student status described above. A student member shall have the same privileges as an Associate member of the Society.

Sec. 2. All applications for membership or transfer should be made on blank forms provided for the purpose, and shall give a complete record of the applicant's education and experience. Honorary and Fellow grades may not be applied for.

Sec. 3. (a) Honorary membership may be granted upon recommendation of the Honorary Membership Committee when confirmed first by a three-fourths majority vote of those present at a meeting of the Board of Governors, and then by a four-fifths majority vote of all voting members present at any regular meeting or at a special meeting called as stated in the bylaws. An Honorary member shall be exempt from the payment of all dues.

(b) Upon recommendation of the Fellow Award Committee, when confirmed by a three-fourths majority vote by those present at a meeting of the Board of Governors, an Active member may be made a Fellow.

(c) An Applicant for Active membership shall give as references at least two members of the grade applied for or of a higher grade. Applicants shall be elected to membership by a three-fourths majority vote of the entire membership of the appropriate Admissions Committee. An applicant may appeal to the Board of Governors if not satisfied with the action of the Admissions Committee, in which case approval of at least three-fourths of those present at a meeting of the Board of Governors shall be required for election to membership or to change the action taken by the Admissions Committee.

(d) An applicant for Associate membership shall give as reference one member of the Society, or two persons not members of the Society who are associated with the motion picture, television, or allied industry. Applicants shall be elected to membership by approval of the Chairman of the appropriate Admissions Committee.

(e) An applicant for Student membership shall be sponsored by a member of the Society, or by a member of the staff of the department of the institution he is attending, this faculty member not necessarily being a member of the Society. Applicants shall be elected to membership by approval of the Chairman of the appropriate Admissions Committee.

Sec. 4. Any member may be suspended or expelled for cause by a majority vote of the entire Board of Governors, provided he shall be given notice and a copy in writing of the charges preferred against him, and shall be afforded opportunity to be heard ten days prior to such action.

BYLAW II

Officers

Sec. 1. An officer or governor shall be an Honorary member, Fellow, or an Active member.

BYLAW III

Board of Governors

Sec. 1. The Board of Governors shall transact the business of the Society in accordance with the Constitution and Bylaws.

Sec. 2. The Board of Governors may act on special resolutions between meetings, by letter ballot authorized by the President. An affirmative vote from a majority of the total membership of the Board of Governors shall be required for approval of such resolutions.

Sec. 3. A quorum of ten members of the Board of Governors shall be present to vote on resolutions presented at any meeting. Unless otherwise specified, a majority vote of the Governors present shall constitute approval of a resolution.

Sec. 4. A member of the Board of Governors may not authorize an alternate to act or vote in his stead.

Sec. 5. Vacancies in the offices or on the Board of Governors shall be filled by the Board of Governors until the annual elections of the Society.

Sec. 6. The Board of Governors, when filling vacancies in the offices or on the Board of Governors, shall endeavor to appoint persons who in the aggregate are representative of the various branches or organizations of the industries interested in the activities of the Society to the end that there shall be no substantial predominance upon the Board, as the result of its own action, of representatives of any one or more branches or organizations of such industries.

Sec. 7. The time and place of all except special meetings of the Board of Governors shall be determined by the Board of Governors.

Sec. 8. Special Meetings of the Board of Governors shall be called by the President with the proviso that no meeting shall be called without at least seven days prior notice to all members of the Board by letter or telegram. Such a notice shall state the purpose of the meeting.

BYLAW IV

Administrative Practices

Sec. 1. Special rules relating to the administration of the Society and known as Administrative Practices shall be established by the Board of Governors and shall be added to or revised as necessary to the efficient pursuit of the Society's objectives.

BYLAW V

Committees

Sec. 1. All committees, except as otherwise specified, shall be formed and appointed in accordance with the Administrative Practices as determined by the Board of Governors.

Sec. 2. All committees, except as otherwise specified, shall be appointed to act for the term served by the officer charged with appointing the committees or until he terminates the appointment.

Sec. 3. Chairmen of the committees shall not be eligible to serve in such capacity for more than two consecutive terms.

Sec. 4. Standing Committees of the Society to be appointed by the President and confirmed by the Board of Governors are as follows:

Honorary Membership Committee
Journal Award Committee
Nominating Committee
Progress Medal Award Committee
Public Relations Committee
Samuel L. Warner Memorial Award Committee

Sec. 5. There shall be an Admissions Committee for each Section of the Society composed of a chairman and three members of which at least two shall be members of the Board of Governors.

Sec. 6. There shall be a Fellow Award Committee composed of all the officers and section chairmen of the Society under the chairmanship of the Past-President. In case the chairmanship is vacated it shall be temporarily filled by appointment by the President.

BYLAW VI

Meetings of the Society

Sec. 1. The location and time of each meeting or convention of the Society shall be determined by the Board of Governors.

Sec. 2. The grades of membership entitled to vote are defined in Bylaw I.

Sec. 3. A quorum of the Society shall consist in number of $\frac{1}{15}$ of the total of those qualified to vote as listed in the Society's records at the close of the last fiscal year before the meeting.

Sec. 4. The annual meeting shall be held during the fall convention.

Sec. 5. Special meetings may be called by the President and upon the request of any three members of the Board of Governors not including the President.

Sec. 6. All members of the Society in any grade shall have the privilege of discussing technical material presented before the Society or its Sections.

BYLAW VII

Duties of Officers

Sec. 1. The President shall preside at all business meetings of the Society and shall perform the duties pertaining to that office. As such he shall be the chief executive of the Society, to whom all other officers shall report.

Sec. 2. In the absence of the President, the officer next in order as listed in Article V of the Constitution shall preside at meetings and perform the duties of the President.

Sec. 3. The seven officers shall perform the duties separately enumerated below and those defined by the President:

(a) The Executive Vice-President shall represent the President, and shall be responsible for the supervision of the general affairs of the Society as directed by the President.

The President and the Executive Vice-President shall not both reside in the geographical area of the same Society Section, but one of these officers shall reside in the vicinity of the executive offices. Should the President or Executive Vice-President remove his residence to the same geographical area of the United States as the other, the office of Executive Vice-President shall immediately become vacant and a new Executive Vice-President shall be elected by the Board of Governors for the unexpired portion of the term.

(b) The Engineering Vice-President shall appoint all technical committees. He shall be responsible for the general initiation, supervision, and co-ordination of the work of these committees.

(c) The Editorial Vice-President shall be responsible for the publication of the Society's *Journal* and all other Society publications.

(d) The Financial Vice-President shall be responsible for the financial operations of the Society, and shall conduct them in accordance with budgets prepared by him and approved by the Board of Governors.

(e) The Convention Vice-President shall be responsible for the national conventions of the Society. He shall arrange for at least one annual convention to be held in the fall of the year.

Sec. 4. The Secretary shall keep a record of all meetings; and shall have the re-

sponsibility for the care and custody of records, and the seal of the Society.

Sec. 5. The Treasurer shall have charge of the funds of the Society and disburse them as and when authorized by the Financial Vice-President. He shall be bonded in an amount to be determined by the Board of Governors, and his bond shall be filed with the Secretary.

Sec. 6. Each officer of the Society, upon the expiration of his term of office, shall transmit to his successor a memorandum outlining the duties and policies of his office.

BYLAW VIII

Society Elections

Sec. 1. All officers and governors shall be elected to their respective offices by a majority of ballots cast by voting members in the following manner:

Nominations shall first be presented by a Nominating Committee appointed by the President, consisting of nine members, including a Chairman. The committee shall be made up of two Past-Presidents, three members of the Board of Governors not up for election, and four other voting members, not currently officers or governors of the Society. Nominations shall be made by three-quarters affirmative vote of the total Nominating Committee.

Not less than three months prior to the Annual Fall Meeting, the Board of Governors shall review the recommendations of the Nominating Committee, which shall have nominated suitable candidates for each vacancy.

Such nominations shall be final unless any nominee is rejected by a three-quarters vote of the Board of Governors present and voting. The Secretary shall then notify these candidates of their nomination. From the list of acceptances, not more than three names for each vacancy shall be selected by the Board of Governors and placed on a letter ballot. A blank space shall be provided on this letter ballot under each office, in which space the name of any voting member other than those suggested by the Board of Governors may be voted for. The balloting shall then take place. The ballot shall be enclosed with a blank envelope and a business reply envelope bearing the Secretary's address and a space for the member's name and address. One set of these shall be mailed to each voting member of the Society, not less than forty days in advance of the Annual Fall Meeting.

The voter shall then indicate on the ballot one choice for each vacancy, seal the ballot in the blank envelope, place this in the envelope addressed to the Secretary, sign his name and address on the latter, and mail it in accordance with the instructions printed on the ballot. No marks of any kind except those above prescribed shall be placed upon the ballots or envelopes. Voting shall close seven days before the opening session of the annual fall convention.

The sealed envelope shall be delivered by the Secretary to a Committee of Tellers appointed by the President at the annual fall convention. This committee shall then examine the return envelopes, open and count the ballots, and announce the results of the election.

The newly-elected officers and governors of the Society shall take office on January 1, following their election.

BYLAW IX

Dues and Indebtedness

Sec. 1. The annual dues shall be fifteen dollars ($15) for Fellows and Active members, ten dollars ($10) for Associate members, and five dollars ($5) for Student members, payable on or before January 1, of each year. Current or first year's dues for new members in any calendar year shall be at the full annual rate for those notified of election to membership on or before June 30; one half the annual rate for those notified of election to membership in the Society on or after July 1.

Sec. 2. (a) Transfer of membership to a higher grade may be made at any time subject to the requirements for initial membership in the higher grade. If the transfer is made on or before June 30, the annual dues of the higher grade are required. If the transfer is made on or after July 1, and the member's dues for the full year have been paid, one half of the annual dues of the higher grade is payable less one half the annual dues of the lower grade.

(b) No credit shall be given for annual dues in a membership transfer from a higher to a lower grade, and such transfers shall take place on January 1, of each year.

Sec. 3. Annual dues shall be paid in advance.

Sec. 4. Failure to pay dues may be considered just cause for suspension.

BYLAW X

Publications

Sec. 1. The Society shall publish a technical magazine to consist of twelve monthly issues, in two volumes per year. The editorial policy of the *Journal* shall be based upon the provisions of the Constitution and a copy of each issue shall be supplied to each member in good standing mailed to his last address of record. Copies may be made available for sale at a price approved by the Board of Governors.

BYLAW XI

Local Sections

Sec. 1. Sections of the Society may be authorized in any locality where the voting membership exceeds twenty. The geographic boundaries of each Section shall be determined by the Board of Governors. Upon written petition for the authorization of a Section of the Society, signed by twenty or more voting members, the Board of Governors may grant such authorization.

Section Membership

Sec. 2. All members of the Society of Motion Picture and Television Engineers in good standing residing within the geographic boundaries of any local Section shall be considered members of that Section.

Sec. 3. Should the enrolled voting membership of a Section fall below twenty, or should the technical quality of the presented papers fall below an acceptable level, or the average attendance at meetings not warrant the expense of maintaining that Section, the Board of Governors may cancel its authorization.

Section Officers

Sec. 4. The officers of each Section shall be a Chairman and a Secretary-Treasurer. The Section chairmen shall be ex-officio members of the Board of Governors and shall continue in such positions for the duration of their terms as chairmen of the local Sections. Each Section officer shall hold office for one year, or until his successor is chosen.

Section Board of Managers

Sec. 5. The Board of Managers shall consist of the Section Chairman, the Section Past-Chairman, the Section Secretary-Treasurer, and six voting members. Each manager of a Section shall hold office for two years. Vacancies shall be filled by appointment by the Board of Managers until the annual election of the Section.

Section Elections

Sec. 6. The officers and managers of a Section shall be voting members of the Society. All officers and managers shall be elected to their respective offices by a majority of ballots cast by the voting members residing in the geographical area of the Section. Not less than three months prior to the annual fall convention of the Society, nominations shall be presented to the Board of Managers of the Section by a Nominating Committee appointed by the Chairman of the Section, consisting of seven members, including a chairman. The committee shall be composed of the present Chairman, the Past-Chairman, two other members of the Board of Managers not up for election, and three other voting members of the Section not currently officers or managers of the Section. Nominations shall be made by a three-quarters affirmative vote of the total Nominating Committee. Such nominations shall be final, unless any nominee is rejected by a three-quarters vote of the Board of Managers, and in the event of such rejection the Board of Managers will make its own nomination.

The Chairman of the Section shall then notify the candidates of their nomination. From the list of acceptances, not more than three names for each vacancy shall be selected by the Board of Managers and placed on a letter ballot. A blank space shall be provided on this letter ballot under each office, in which space the name of any voting member other than those suggested by the Board of Managers may be voted for. The balloting shall then take place. The ballot shall be enclosed with a blank envelope and a business reply envelope bearing the local Secretary-Treasurer's address and a space for the member's name and address. One of these shall be mailed to each voting member of the Society residing in the geographical

area covered by the Section, not less than forty days in advance of the annual fall convention.

The voter shall then indicate on the ballot one choice for each office, seal the ballot in the blank envelope, place this in the envelope addressed to the Secretary-Treasurer, sign his name and address on the latter, and mail it in accordance with the instructions printed on the ballot. No marks of any kind except those above prescribed shall be placed upon the ballots or envelopes. Voting shall close seven days before the opening session of the annual fall convention. The sealed envelopes shall be delivered by the Secretary-Treasurer to his Board of Managers at a duly called meeting. The Board of Managers shall then examine the returned envelopes, open and count the ballots, and announce the results of the election.

The newly-elected officers and managers shall take office on January 1, following their election.

Section Business

Sec. 7. The business of a Section shall be conducted by the Board of Managers.

Section Expenses

Sec. 8. (a) At the beginning of each fiscal year, the Secretary-Treasurer of each section shall submit to the Board of Governors of the Society a budget of expenses for the year.

(b) The Treasurer of the Society shall deposit with each Section Secretary-Treasurer a sum of money for current expenses, the amount to be fixed by the Board of Governors.

(c) The Secretary-Treasurer of each Section shall send to the Treasurer of the Society, quarterly or on demand, an itemized account of all expenditures incurred during the preceding period.

(d) Expenses other than those enumerated in the budget, as approved by the Board of Governors of the Society, shall not be payable from the general funds of the Society without express permission from the Board of Governors.

(e) The Section Board of Managers shall defray all expenses of the Section not provided for by the Board of Governors, from funds raised locally.

(f) The Secretary of the Society shall, unless otherwise arranged, supply to each Section all stationery and printing necessary for the conduct of its business.

Section Meetings

Sec. 9. The regular meetings of a Section shall be held in such places and at such hours as the Board of Managers may designate. The Secretary-Treasurer of each Section shall forward to the Secretary of the Society, not later than five days after a meeting of a Section, a statement of the attendance and of the business transacted.

Constitution and Bylaws

Sec. 10. Sections shall abide by the Constitution and Bylaws of the Society and conform to the regulations of the Board of Governors. The conduct of Sections shall always be in conformity with the general policy of the Society as fixed by the Board of Governors.

BYLAW XII

Student Chapters

Sec. 1. Student Chapters of the Society may be authorized in any college, university, or technical institute of collegiate standing. Upon written petition for the authorization of a Student Chapter, signed by twelve or more Society members, or applicants for Society membership, and the Faculty Adviser, the Board of Governors may grant such authorization.

Chapter Membership

Sec. 2. All members of the Society in good standing who are attending the designated educational institution shall be eligible for membership in the Student Chapter, and when so enrolled they shall be entitled to all privileges that such Student Chapter may, under the Constitution and Bylaws, provide.

Sec. 3. Should the membership of the Student Chapter fall below ten, or the average attendance of meetings not warrant the expense of maintaining the organization, the Board of Governors may cancel its authorization.

Chapter Officers

Sec. 4. The officers of each Student Chapter shall be a Chairman and a Secretary-Treasurer. Each Chapter officer shall hold office for one year, or until his

successor is chosen. Where possible, officers shall be chosen in May to take office at the beginning of the following school year. The procedure for holding elections shall be prescribed in Administrative Practices.

Faculty Adviser

Sec. 5. A member of the faculty of the same educational institution shall be designated by the Board of Governors as Faculty Adviser. It shall be his duty to advise the officers on the conduct of the Chapter and to approve all reports to the Secretary and the Treasurer of the Society.

Chapter Expenses

Sec. 6. The Treasurer of the Society shall deposit with each Chapter Secretary-Treasurer a sum of money, the amount to be fixed by the Board of Governors. The Secretary-Treasurer of the Chapter shall send to the Treasurer of the Society at the end of each school year or on demand an itemized account of all expenditures incurred.

Chapter Meetings

Sec. 7. The Chapter shall hold at least four meetings per year. The Secretary-Treasurer shall forward to the Secretary of the Society at the end of each school year a report of the meetings for that year, giving the subject, speaker, and approximate attendance for each meeting.

BYLAW XIII

Amendments

Sec. 1. Proposed amendments to these Bylaws may be initiated by the Board of Governors or by a recommendation to the Board of Governors signed by ten voting members. Proposed amendments may be approved at any regular meeting of the Society at which a quorum is present, by the affirmative vote of two-thirds of the members present and eligible to vote thereon. Such proposed amendments shall have been published in the *Journal* of the Society, in the issue next preceding the date of the stated business meeting of the Society at which the amendment or amendments are to be acted upon.

Sec. 2. In the event that no quorum of the voting members is present at the time of the meeting referred to in Sec. 1, the amendment or amendments shall be referred for action to the Board of Governors. The proposed amendment or amendments then become a part of the Bylaws upon receiving the affirmative vote of three-quarters of the entire membership of the Board of Governors.

Officers of the Society April, 1952

Herbert Barnett
Executive Vice-President
1951–52

Peter Mole
President
1951–52

Earl I. Sponable
Past-President
1951–52

Fred T. Bowditch
Engineering Vice-President
1952–53

John G. Frayne
Editorial Vice-President
1951–52

Frank E. Cahill, Jr.
Financial Vice-President
1952–53

William C. Kunzmann
Convention Vice-President
1951–52

Robert M. Corbin
Secretary
1951–52

Barton Kreuzer
Treasurer, 1952–53

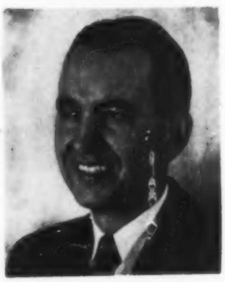
Frank E. Carlson
Governor, 1951–52

William B. Lodge
Governor, 1951–52

Thomas T. Moulton
Governor, 1951–52

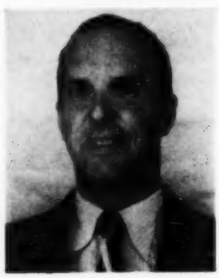
Oscar F. Neu
Governor, 1951–52

Norwood L. Simmons
Governor, 1951–52



Malcolm G. Townsley
Governor, 1951–52

Joseph E. Aiken
Governor, 1952–53



Fred G. Albin
Governor, 1952–53

George W. Colburn
Governor, 1952–53

Ellis W. D'Arcy
Governor, 1952–53

JOHN K. HILLIARD
Governor, 1952–53

AXEL G. JENSEN
Governor, 1952–53

C. E. HEPPBERGER
Governor, 1952

VAUGHN C. SHANER
Governor, 1952

E. M. STIFLE
Governor, 1952

OFFICERS AND MANAGERS OF SECTIONS

ATLANTIC COAST: *Chairman,* E. M. Stifle; *Secretary-Treasurer,* H. C. Milholland; *Managers,* E. A. Bertram, H. A. Chinn, F. N. Gillette, Richard Hodgson, D. B. Joy, John G. Stott.

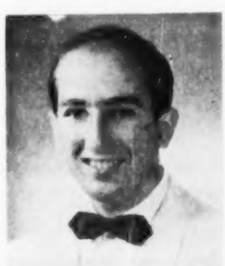
CENTRAL: *Chairman,* C. E. Heppberger; *Secretary-Treasurer,* J. L. Wassell; *Managers,* E. E. Bickel, W. C. Eddy, I. F. Jacobsen, K. M. Mason, R. H. Ray, M. G. Townsley.

PACIFIC COAST: *Chairman,* Vaughn C. Shaner; *Secretary-Treasurer,* P. C. Caldwell; *Managers,* F. G. Albin, A. C. Blaney, L. G. Dunn, A. M. Gundelfinger, W. F. Kelley, R. E. Lovell.

STUDENT CHAPTER OFFICERS

NEW YORK UNIVERSITY:
Under Reorganization

UNIVERSITY OF SOUTHERN CALIFORNIA: *Chairman,* Donald Stern; *Secretary-Treasurer,* Arthur Schneider



DONALD STERN
Chairman, 1952

Treasurer's Report—January 1 — December 31, 1951

CASH			
Cash on Deposit, Regular Account, Chase National Bank, January 1, 1951		$30,093.92	
Net Receipts		(27,857.40)	
Cash on Deposit, Regular Account, December 31, 1951			$ 2,236.52
Cash on Deposit, Payroll Account, Chase National Bank, January 1, 1951	——		
Deposits	41,400.00		
Total		41,400.00	
Disbursements		41,302.00	
Cash on Deposit, Payroll Account, December 31, 1951			98.00
Petty Cash Fund			200.00
Total Cash on Deposit and on Hand			2,534.52
INVESTMENTS			
Savings Accounts, January 1, 1951	31,419.71		
Add: Interest Credited	927.63		
Total	32,347.34		
Less: Account Closed	5,138.43		
Savings Accounts, December 31, 1951		27,208.91	
U.S. Government Bonds (at cost)		60,000.00	
Total Investments			87,208.91
Total Cash and Investments, December 31, 1951			$89,743.43

Respectfully submitted,
FRANK E. CAHILL, Jr., *Treasurer*

Summary of Financial Condition—Dec. 31, 1951

ASSETS (What Your Society Owns)	
Cash on Hand and in Bank	$ 2,534.52
Savings Accounts	27,208.91
U.S. Government Bonds (at cost)	60,000.00
Accounts Receivable	21,719.86
Test Film Inventory	53,019.81
Test Film Equipment (memo value)	1.00
Office Furniture and Equipment (memo value)	1.00
Prepaid Expenses	63.00
Total Assets	$164,548.10
LIABILITIES (What Your Society Owes)	
Accounts Payable	$ 22,640.07
Due to Customers	860.85
Membership Dues Received in Advance	12,687.85
N.Y.C. Sales Tax Payable	14.38
Reserve for 1955 Five-Year Index	500.00
Total Liabilities	$ 36,703.15
MEMBERS' EQUITY (What Your Society Is Worth)	127,844.95
Total Liabilities and Members' Equity	$164,548.10

Statement of Income and Expenses

January 1 — December 31, 1951

Test Film Operations		
Test Film Sales	$133,746.17	
Cost of Test Films Sold	79,148.48	
Net Income From Test Film Operations		$54,597.69
Publications Operations		
Publications Income	$ 20,774.36	
Cost of Publications	45,467.44	
Net Loss From Publications Operations		(24,693.08)
Other Operations		
Other Operations Income	$ 388.49	
Cost of Other Operations	710.56	
Net Loss From Other Operations		(322.07)
Other Income		
Membership Dues	$ 60,511.51	
Interest Earned	2,454.70	
Miscellaneous Income	101.11	
Total Other Income		63,067.32
Total Operating Income		$92,649.86
Operating Expenses		
Engineering	$ 13,026.44	
Administrative	59,866.31	
Officers	108.85	
Sections and Chapters	2,700.00	
Affiliations	1,385.00	
Conventions	1,230.06	
Total Operating Expenses		78,316.66
Net Operating Income		$14,333.20
Other Deductions		
Depreciation of Test Film Equipment	$ 3,729.85	
Excess in Reserve for 1950 Five-Year Index	(453.53)	
Provision for 1955 Five-Year Index	500.00	
Total Other Deductions		3,776.32
Excess of Income Over Expenses		$10,556.88

The foregoing financial statements were prepared from the records of the Society for the year 1951 and reflect the results of operations for that year. The records and financial statements were audited for the year ended December 31, 1951, by Wilbur A. Smith, Certified Public Accountant, New York City, and are in conformity with that audit.

RALPH B. AUSTRIAN, *Financial Vice-President*

Membership Report

For Year Ended December 31, 1951

	Hon.	Sust.	Fel.	Act.	Assoc.	Stud.	Total
Membership, January 1, 1951	4	79	198	931	1887	184	3283
New Members		2		171	291	67	531
Reinstatements				10	20	6	36
	4	81	198	1112	2198	257	3850
Resignations		−2	−2	−15	−27	−5	−51
Deceased	−1		−3	−5	−8		−17
Delinquent		−3	−2	−72	−194	−23	−294
	3	76	191	1020	1969	229	3488
Changes in Grade:							
Active to Fellow			16	−16			
Associate to Active				114	−114		
Student to Associate					14	−14	
Active to Associate				−4	4		
Membership, December 31, 1951	3	76	207	1114	1873	215	3488

Nonmember Subscription Report

For Year Ended December 31, 1951

Subscriptions, January 1, 1951	575
New Subscriptions and Previous Cutoffs	892
	1467
Cutoffs and Expirations	439
Subscriptions, December 31, 1951	1028

Awards

In accordance with the provisions of the Administrative Practices of the Society and the regulations for granting the Journal Award, the Progress Medal Award, the Samuel L. Warner Memorial Award and the David Sarnoff Gold Medal Award, a list of names of previous recipients and the reasons for the awards are published annually in the *Journal* as follows:

Journal Award

The Journal Award Committee shall consist of five Fellows or Active members of the Society, appointed by the President and confirmed by the Board of Governors. The Chairman of the Committee shall be designated by the President.

At the fall convention of the Society a Journal Award Certificate shall be presented to the author or to each of the authors of the most outstanding paper originally published in the *Journal* of the Society during the preceding calendar year.

Other papers published in the *Journal* of the Society may be cited for Honorable Mention at the option of the Committee, but in any case should not exceed five in number.

The Journal Award shall be made on the basis of the following qualifications:

(1) The paper must deal with some technical phase of motion picture engineering.

(2) No paper given in connection with the receipt of any other Award of the Society shall be eligible.

(3) In judging of the merits of the paper, three qualities shall be considered, with the weights here indicated: (a) technical merit and importance of material, 45%; (b) originality and breadth of interest, 35%; and (c) excellence of presentation of the material, 20%.

A majority vote of the entire Committee shall be required for the election to the Award. Absent members may vote in writing.

The report of the Committee shall be presented to the Board of Governors at their July meeting for ratification.

These regulations, a list of the names of those who have previously received the Journal Award, the year of each Award, and the titles of the papers shall be published annually in the *Journal* of the Society. In addition, the list of papers selected for Honorable Mention shall be published in the *Journal* of the Society during the year current with the Award.

The recipients are listed below by year, with the date of *Journal* publication given after the title.

1934, P. A. Snell, "An introduction to the experimental study of visual fatigue," May 1933.

1935, L. A. Jones and J. H. Webb, "Reciprocity law failure in photographic exposure," Sept. 1934.

1936, E. W. Kellogg, "A comparison of variable-density and variable-width systems," Sept. 1935.

1937, D. B. Judd, "Color blindness and anomalies of vision," June 1936.

1938, K. S. Gibson, "The analysis and specification of color," Apr. 1937.

1939, H. T. Kalmus, "Technicolor adventures in cinemaland," Dec. 1938.

1940, R. R. McNath, "The surface of the nearest star," Mar. 1939.

1941, J. G. Frayne and Vincent Pagliarulo, "The effects of ultraviolet light on variable-density recording and printing, June 1940.

1942, W. J. Albersheim and Donald MacKenzie, "Analysis of soundfilm drives," July 1941.

1943, R. R. Scoville and W. L. Bell, "Design and use of noise-reduction bias systems," Feb. 1942 (Award made Apr. 1944).

1944, J. I. Crabtree, G. T. Eaton and M. E. Muehler, "Removal of hypo and silver salts from photographic materials as affected by the composition of the processing solutions," July 1943.

1945, C. J. Kunz, H. E. Goldberg and C. E. Ives, "Improvement in illumination efficiency of motion picture printers," May 1944.

946, R. H. Talbot, "The projection life of film," Aug. 1945.

1947, Albert Rose, "A unified approach to the performance of photographic film, television pickup tubes, and the human eye," Oct. 1946.

1948, J. S. Chandler, D. F. Lyman and L. R. Martin, "Proposals for 16-mm and 8-mm sprocket standards," June 1947.

1949, F. G. Albin, "Sensitometric aspect of television monitor-tube photography," Dec. 1948.

1950, Frederick J. Kolb, Jr., "Air cooling of motion picture film for higher screen illumination," Dec. 1949.

1951, A. B. Jennings, W. A. Stanton and J. P. Weiss, "Synthetic color-forming binders for photographic emulsions," Nov. 1950.

The present Chairman of the Journal Award Committee is Frederick J. Kolb, Jr.

Progress Medal Award

The Progress Medal Award Committee shall consist of five Fellows or Active members of the Society, appointed by the President and confirmed by the Board of Governors. The Chairman of the Committee shall be designated by the President.

The Progress Medal may be awarded each year to an individual in recognition of any invention, research or development which, in the opinion of the Committee, shall have resulted in a significant advance in the development of motion picture technology.

Any member of the Society may recommend persons deemed worthy of the Award. The recommendation in each case shall be in writing and in detail as to the accomplishments which are thought to justify consideration. The recommendation shall be seconded in writing by any two Fellows or Active members of the Society, who shall set forth their knowledge of the accomplishments of the candidate which, in their opinion, justify consideration.

A majority vote of the entire Committee shall be required to constitute an Award of the Progress Medal. Absent members may vote in writing.

The report of the Committee shall be presented to the Board of Governors at their July meeting for ratification.

The recipient of the Progress Medal shall be asked to present a photograph of himself to the Society and, at the discretion of the Committee, may be asked to prepare a paper for publication in the *Journal* of the Society.

These regulations, a list of the names of those who have previously received the Medal, the year of each Award and a statement of the reason for the Award shall be published annually in the *Journal* of the Society.

Awards have been made as follows:

1935, E. C. Wente, for his work in sound recording and reproduction, Dec. 1935.

1936, C. E. K. Mees, for his work in photography, Dec. 1936.

1937, E. W. Kellogg, for his work in sound reproduction, Dec. 1937.

1938, H. T. Kalmus, for his work in developing color motion pictures, Dec. 1938.

1939, L. A. Jones, for his scientific researches in photography, Dec. 1939.

1940, Walt Disney, for his contributions to motion picture photography and sound recording of feature and short cartoon films, Dec. 1940.

1941, G. L. Dimmick, for his development activities in motion picture sound recording, Dec. 1941.

No Awards were made in 1942 and 1943.

1944, J. G. Capstaff, for his research and development of films and apparatus used in amateur cinematography, Jan. 1945.

No Awards were made in 1945 and 1946.

1947, J. G. Frayne, for his technical achievements and the documenting of his work in addition to his contributions to the field of education and his inspiration to his fellow engineers, Jan. 1948.

1948, Peter Mole for his outstanding achievements in motion picture studio

lighting which set a pattern for lighting techniques and equipment for the American motion picture industry, Jan. 1949.

1949, Harvey Fletcher for his outstanding contributions to the art of recording and reproducing of sound for motion pictures, Oct. 1949

1950, V. K. Zworykin, for his outstanding contributions to the development of television, Dec. 1950.

1951, Earl I. Sponable, for outstanding contributions to technical advancement of the motion picture art, particularly with respect to sound on film, color and large-screen television, Dec. 1951.

The present Chairman of the Progress Medal Award Committee is D. B. Joy.

Samuel L. Warner Memorial Award

Each year the President shall appoint a Samuel L. Warner Memorial Award Committee consisting of a chairman and four members. The chairman and committee members must be Active Members or Fellows of the Society. In considering candidates for the Award, the committee shall give preference to inventions or developments occurring in the last five years. Preference should also be given to the invention or development likely to have the widest and most beneficial effect on the quality of the reproduced sound and picture. A description of the method or apparatus must be available for publication in sufficient detail so that it may be followed by anyone skilled in the art. Since the Award is made to an individual, a development in which a group participates should be considered only if one person has contributed the basic idea and also has contributed substantially to the practical working out of the idea. If, in any year, the committee does not consider any recent development to be more than the logical working out of details along well-known lines, no recommendation for the Award shall be made. The recommendation of the committee shall be presented to the Board of Governors at the July meeting.

The purpose of this Award is to encourage the development of new and improved methods or apparatus designed for sound-on-film motion pictures, including any step in the process.

Any person, whether or not a member of the Society of Motion Picture and Television Engineers, is eligible to receive the Award.

The Award shall consist of a gold medal suitably engraved for each recipient. It shall be presented at the Fall Convention of the Society, together with a bronze replica.

These regulations, a list of those who previously have received the Award, and a statement of the reason for the Award shall be published annually in the *Journal* of the Society. The recipients have been:

1947, J. A. Maurer, for his outstanding contributions to the field of high-quality 16-mm sound recording and reproduction, film processing, development of 16-mm sound test films, and for his inspired leadership in industry standardization (citation published, Jan. 1948).

1948, Nathan Levinson, for his outstanding work in the field of motion picture sound recording, the intercutting of variable-area and variable-density sound tracks, the commercial use of control track for extending volume range, and the use of the first soundproof camera blimps (citation published, Jan. 1949).

1949, R. M. Evans, for his outstanding work in the field of color motion picture films, including research on visual effects in photography and development work on commercial color processes (citation published, Oct. 1949).

1950, Charles R. Fordyce, for his efforts in and achievement of the development of triacetate safety base film (citation published, Dec. 1950).

1951, Earl I. Sponable, for years of research and development in recording of sound on film (citation published Dec. 1951).

The present Chairman of the Samuel L. Warner Memorial Award Committee is Glenn L. Dimmick.

David Sarnoff Gold Medal Award

The David Sarnoff Gold Medal Award Committee, appointed by the President, shall consist of five Fellows, Honorary Members or former recipients of some formal Society Award, each of whom shall be qualified to judge the importance or value of current work in some technical phase of the broad field of television engineering, whether in research, development, design, manufacture, operation, or in any similar phase of theater television.

The award shall consist of a gold medal, together with a bronze replica and a citation, stating the recipient's qualifications.

The David Sarnoff Gold Medal may be awarded each year to any qualified individual, whether or not currently a member of this Society, in recognition of recent technical contributions to the art of television, to encourage the development of new techniques, new methods and new equipment which hold promise for the continued improvement of television, preference to be given for work having reached completion within the preceding five years.

Recommendations of the Committee and a report of its deliberations shall be presented to the Board of Governors three months in advance of the time for presentation (at the July meeting of the Board, for presentation at the Fall Convention). Any member of the Society may recommend persons deemed worthy of the Award. The recommendation in each case shall be in writing and in detail as to the accomplishments which are thought to justify consideration.

These regulations, a list of the names of those who have previously received the medal, the year of each Award and a statement of the reason for the Award shall be published annually in the *Journal* of the Society. The first recipient is:

1951, Otto H. Schade, for his outstanding accomplishments in the fields of television and motion picture science and engineering, in outlining the potentialities of television and film systems as to fidelity of photography and reproduction of images (citation published Dec. 1951).

The present Chairman of the David Sarnoff Gold Medal Award Committee is Pierre Mertz.

HONORARY MEMBERS

Lee de Forest
Edward W. Kellogg
A. S. Howell
V. K. Zworykin

The distinction of Honorary Membership in the Society is awarded to living pioneers whose basic contributions when examined through the perspective of time represent a substantial forward step in the recorded history of the arts and sciences with which the Society is most concerned.

SMPTE HONOR ROLL

Louis Aimé Augustin Le Prince
William Friese-Greene
Thomas Alva Edison
George Eastman
Frederic Eugene Ives
Jean Acme Le Roy
C. Francis Jenkins
Eugene Augustin Lauste
William Kennedy Laurie Dickson
Edwin Stanton Porter
Herman A. DeVry
Robert W. Paul
Frank H. Richardson
Leon Gaumont
Theodore W. Case
Edward B. Craft
Samuel L. Warner
Louis Lumiere
Thomas Armat

Elevation to the Honor Roll of the Society is granted to each distinguished pioneer who during his lifetime was awarded Honorary Membership or whose work was recognized subsequently as fully meriting that award.

1952 Nominations

Candidates for election to national office of the Society are now being considered by the Nominating Committee. The eleven vacancies which will occur at the end of 1952 and are to be filled by this year's election are the offices of President, Executive Vice-President, Editorial Vice-President, Convention Vice-President, Secretary, two Governors from the West, two Governors from the Central area, and two Governors from the East. Names of the incumbents will be found on the inside back cover of each issue of the *Journal*.

Members in the Honorary, Fellow and Active Grades are invited by the Chairman of the Nominating Committee to submit their suggestions for candidates at the earliest possible dates. Address them to Earl I. Sponable, Movietonews, Inc., 460 W. 54th St., New York 19, N.Y.

Papers on Photographic Instrumentation

Instrumentation is the subject of this year's symposium of the Society of Photographic Engineers, to be held on June 4 and 5 at the Naval Ordnance Laboratory, White Oak, Md., according to information from SPE President Edward K. Kaprelian. The symposium will cover equipments, materials and techniques involved in the recording of data. Papers relating to high-speed cinematography will not be presented. Information about possible instrumentation papers will be welcomed by the symposium chairman, D. Max Beard, 4304 S. Capitol, Washington 20, D.C.

Book Reviews

Television Engineering (Second Edition)

By D. G. Fink. Published (1952) by McGraw-Hill, 330 W. 42 St., New York 36. i-xiv + 690 pp. + 12 pp. appendix + 19 pp. index. 512 illus. 6 × 9 in. Price $8.50.

Mr. Fink is one of those all too rare individuals—an engineer who can write. His previous books have been noted for their clear, lucid style and one would be disappointed if this one were not up to his previous standards. As a matter of fact, it is, if anything, superior to his earlier books in this respect and he has succeeded in turning out a text book for television engineering which is extremely clear and well written.

The book covers the entire field of television engineering starting with the fundamentals and progressing to a fairly detailed description of commercial television transmitting studio and receiving equipment. Two chapters of the book are devoted to an especially good description of color television which includes a consideration of color fundamentals and an objective study of the various systems which have been proposed for the transmission of television pictures and color. Television engineering covers such a wide variety of subject matter, drawing as it does upon combinations of practically all of the physical sciences, that any attempt to cover the entire system in one book will inevitably result in treatment which will seem superficial to the specialists. For example, in his discussion of radio wave propagation, Mr. Fink barely mentions the important work which was done by the FCC Ad Hoc Committee in connection with the determination of a terrain factor which describes the deviation of the median signal intensity from the smooth earth value because of the irregularities in the earth surface. Again, his discussion of the definition obtainable from the various components in the television system is entirely in terms of the resolving power of the various components. He must be ignoring the important work of Schade and

others who have shown that this is not an adequate criterion for picture definition.

The treatment of such a wide variety of subject matter probably leads inevitably to errors of fact which occur from time to time in the book. For example, an equivalent circuit which is supposed to show the input impedance of a balun is shown in Fig. 283; this circuit has a series LC circuit presumably resonant at the center of the frequency band shunted across the input terminals, so that input impedance of this frequency can be a short circuit. Again, on page 326, there is the following description of defraction of energy past the horizon: "Defraction occurs when the instant energy, following tangentially on the rim of the obstacle, is re-radiated from absorbing points on the rim." Even aside from the contradiction in terms involved in re-radiation from an *absorbing* object, this is surely not an accurate description of the phenomena of defraction.

The criticisms of the book described above were meant to illustrate the inevitable difficulties which arise in covering so much territory in one volume and not to deprecate what, in general, represents a very excellent job in doing what it was intended to do. The beginning student of television engineering or the specialist attempting to obtain a broad background in fields other than his own will find the book well organized, readable, and, with a few exceptions such as those noted above, accurate.—*McIntosh & Inglis*, Consulting Radio Engineers, 777 14th St., N.W., Washington 5, D.C.

Prism and Lens Making (Second Edition)

By F. Twyman. Published (1952) by Hilger & Watts Ltd., 98 St. Pancras Way, London, N.W. 1. Distributed in U.S.A. by the Jarrell-Ash Co., 165 Newbury St., Boston, Mass. i-viii + 590 pp. + 27 pp. appendix + 5 pp. bibliography + 7 pp. index. 260 illus. $5\frac{1}{2} \times 8\frac{1}{2}$ in. Price $11.25.

Although this is called a second edition of Twyman's 1942 book on prism and lens making, it is so much larger than the original (629 pages against the former 178) that it might almost be regarded as a new work. Where the previous treatment was stilted and severe, the new is easy to read and full of anecdotes and illustrative material of every kind. Indeed, the number of references to both ancient and recent authorities is extraordinary, and the writing is in the best tradition of Rayleigh or Dennis Taylor.

The chief charge against the previous edition was that only the procedures and techniques in use by Adam Hilger Ltd. were described. This was not very surprising as Mr. Twyman is the *emeritus* Managing Director of Hilger's, but in the new edition this is no longer the case. The author has gone to the greatest trouble to ascertain the methods used by other manufacturers (mainly, however, in England), and has described them impartially. This of course increases the value of the book very greatly, since Hilger's production is small in quantity but wide in variety and of the highest quality, while in some other companies the need for large-scale or mass production of lower-grade lenses has led to the development of entirely different manufacturing procedures.

In addition to a survey of the regular methods for the grinding, polishing, centering and cementing of lenses and prisms, several new chapters have been added dealing with such subjects as optical crystals and plastics and the manufacture of optical elements from them, microscope objectives, large astronomical objectives and mirrors, the surface treatment of lenses, spectacle lenses, and an excellent summary of the methods available for the generation of nonspherical surfaces. Almost 100 pages are devoted to the testing of optical work, both on the individual surfaces and on the completed systems. The tests of Fizeau, Foucault, Newton, Hartmann, Zernicke, and others are fully described, and in a separate chapter the applications of the author's well-known interferometers receive extensive treatment. The nature of glass and its annealing, and workshop tests for optical glass, are well covered.

Among the useful appendices there is a glossary of equivalent terms used in the optical industry in English, French and German. There is an extensive bibliography, and a good index. The paper and printing are excellent, but the review copy as received was poorly bound and

the cover was already falling off. Misprints are negligibly few. This excellent book can be very strongly recommended to all who have a close connection with the optical industry, or any occasion to grind and polish a lens.—*R. Kingslake*, Optical Design Dept., Hawk-Eye Works, Eastman Kodak Co., Rochester 4, N.Y.

Dynamics of the Film

By Joseph and Harry Feldman. Published (1952) by Hermitage House, 8 W. 13 St., New York 11. 241 pp. + 3 pp. bibliography + 2 pp. periodicals listing + 7 pp. index. Illustrated. $5\frac{1}{4} \times 8$ in. Price $3.50.

The main risk in attempting to "popularize" a difficult subject, especially in the field of aesthetics, lies in depriving it of all human and artistic warmth and in reducing it to a mere mechanical stratagem.

In this pitfall is precisely where the Messrs. Feldman have landed. Their book, intended purposely "for the BIG audience of movie-goers," fails to convey the meaning and essence of a film's overall dramatic impact. It is a case of not seeing the forest for the trees, and their analysis of the basic elements of a film constitutes a *reductio ad absurdum* of the approach they have chosen.

To some extent, they seem aware of their predicament. They try to tone down their dogmatic over-simplifications by hedging with carefully worded reservations. One must regretfully state, however, that the book's worthy aim of explaining the nature of film art to the general public falls very short of its fulfillment.—*George L. George*, Screen Directors Guild, 133 E. 40 St., New York 16.

Standards for single-line diagrams for use in both power and communication work combined in one volume in The American Standard Graphical Symbols for Single (One) Line Electrical Engineering Diagrams, Z32.1.1-1951, published by the American Standards Association, 70 E. 45 St., New York 17, at $1.40 per copy. This standard coordinates and modifies the single-line diagrams contained in the American Standard Graphical Symbols for Electrical Power and Control, Z32.3-1946, and for Telephone, Telegraph and Radio Use, Z32.5-1944.

The American Institute of Electrical Engineers and the American Society of Mechanical Engineers were sponsors of the new standard, which contains 81 sections covering symbols for almost all electrical engineering work in the fields of power and communication. Sample diagrams show the use of the single line drawing in illustrations of a laboratory sound system, a microwave test setup telephone repeater and line equipment, and power equipment.

Test films are the customary tool for checking picture and sound performance in theaters, service shops, in factories and in television stations. Twenty-seven different test films in 16mm and 35mm sizes are produced by the Society and the Motion Picture Research Council. Write to Society Headquarters for a free catalog.

Six American Standards have been added to the Motion Picture Set of 60 which the Society has had available for sale. To holders of the present set the Society has made available the six new standards: PH22.11-1952, PH22.24-1952, PH22.73-1951, PH22.74-1951, PH22.76-1951 and PH22.82-1951. The price is $1 plus 3% sales tax on deliveries in New York City.

The new set of 66 standards in a heavy three-post binder with an index is available at $14.50 plus 3% sales tax on deliveries in New York City; foreign postage is $.50 extra.

All standards **in sets only** are available from Society Headquarters. Single copies of any particular standard must be ordered from the American Standards Association, 70 East 45th St., New York 17, N.Y.

New Members

The following members have been added to the Society's rolls since those last published. The designations of grades are the same as those used in the 1950 Membership Directory.

Honorary (**H**) Fellow (**F**) Active (**M**) Associate (**A**) Student (**S**)

Angarola, Salvatore, SRT—TV Studios. **Mail:** 90-50—53 Ave., Elmhurst, L.I., N.Y. (**S**)

Arora, O. P., University of Southern California. **Mail:** 1183½ W. 29 St., Los Angeles 7, Calif. (**S**)

Bartleson, C. James, Jr., Photographic Color Technician, Pavelle Color, Inc. **Mail:** 7018 Colonial Rd., Brooklyn, N.Y. (**A**)

Booth, John H. L., University of Southern California. **Mail:** Ste. C, 2730 S. Normandie, Los Angeles 7, Calif. (**S**)

Bray, Frederic L., Engineer, Du-Art Film Laboratories. **Mail:** 353 Pin Oak La., Westbury, L.I., N.Y. (**A**)

Catanzaro, Carl J., SRT—TV Studios. **Mail:** 27-19—24 Ave., Astoria, L.I., N.Y. (**S**)

Colman, Robert, University of Southern California. **Mail:** 1732¼ W. 20 St., Los Angeles, Calif. (**S**)

Deutch, Irving, New Inst. for Film & Television. **Mail:** 2110 Newkirk Ave., Brooklyn, N.Y. (**S**)

Dickinson, William A., Electronics Engineer, Sylvania Electric Products, Inc., Seneca Falls, N.Y. (**M**)

Doba, Stephen, Jr., Telephone Engineer, Bell Telephone Laboratories, Inc., Murray Hill, N.J. (**A**)

Erlinger, Joseph A., Foreman, Camera Shop, Warner Brothers. **Mail:** 1212 S. Crescent Heights Blvd., Los Angeles 35, Calif. (**A**)

Everest, F. Alton, Associate Director, Moody Institute of Science. **Mail:** 11428 Santa Monica Blvd., Los Angeles 25, Calif. (**A**)

Goren, Lewis, SRT—TV Studios. **Mail:** 124 E. 146 St., New York 51, N.Y. (**S**)

Gregory, John R., New Institute for Motion Pictures. **Mail:** 64-12—65 Pl., Middle Village 79, N.Y. (**S**)

Hall, Frank, Clinical-Surgical Photographer, Dept. of Veterans Affairs, Sunnybrook Hospital. **Mail:** 1068 St. Clair Ave., W., Toronto, Ont., Canada. (**A**)

Hanson, Charles L., Jr., Photographic Technician, Arthur D. Little, Inc. **Mail:** 54 Hammond St., Cambridge 38, Mass. (**A**)

Harber, Richard G., University of Southern California. **Mail:** 7843 Flight Ave., Los Angeles 45, Calif. (**S**)

Hollzer, Herbert M., University of Southern California. **Mail:** 820 S. Mansfield, Los Angeles 36, Calif. (**S**)

Howland, Walter A., Optical Engineer, J. A. Maurer, Inc. **Mail:** 179 Sadler Rd., Bloomfield, N.J. (**A**)

Jacobsen, Michael M., Sound Engineer, A/S Palladium Film. **Mail:** Gustav Adolfs Gade 5, Copenhagen Ø, Denmark. (**A**)

Jamieson, Hugh V., Jr., Production Manager, Partner, Jamieson Film Co. **Mail:** 3825 Bryan, Dallas, Tex. (**M**)

Kayser, Paul W., Foreign Manager, Westrex Corp. **Mail:** 299 S. Middletown Rd., Pearl River, N.Y. (**A**)

Kirk, Michael, Film Editor, WOSM-TV. **Mail:** 2139 Gen. Taylor, New Orleans 15, La. (**M**)

Linton, C. Bruce, University of Southern California. **Mail:** 401 Adlena Dr., Fullerton, Calif. (**S**)

Long, Maurice L., University of Southern California. **Mail:** 3202 W. 43 Pl., Los Angeles 8, Calif. (**S**)

MacIsaac, Donald M., Sound Editor, Syracuse University, Audio-Visual Center. **Mail:** 304 Farmer St., Syracuse, N.Y. (**A**)

Madore, Douglas, Actor, Director, Freelance. **Mail:** 6088 Selma Ave., Hollywood 28, Calif. (**S**)

Mell, Labe B., General Manager, Reela Films, Inc., 17 N.W. Third St., Miami, Fla. (**A**)

Mendelwager, Jerome, SRT—TVStudios. **Mail:** 1016 Boulevard, Bayonne, N.J. (**S**)

Nesbitt, Charles D., Motion Picture Technical Representative, E. I. du Pont de Nemours & Co. **Mail:** 3289 N. California Ave., Chicago, Ill. (**M**)

Netervala, Minoo, University of Southern California. **Mail:** 1190 W. Adams Blvd., Los Angeles 7, Calif. (**S**)

Noriega, Joseph, Motion Picture Producer, Reforma 77, Apt. 1107, Mexico City, Mexico. (**M**)

Oleson, Robert, University of Southern California. **Mail:** 207½ S. Hoover, Los Angeles, Calif. (**S**)

Pascal, Captain Samuel, Hq. Sqd., 131 A.B. Gp., George Air Force Base, Victorville, Calif. (**A**)

Patelis, George, SRT—TV Studios. **Mail:** 87-72—253 St., Bellerose, N.Y. (**S**)

Pritzlaff, Kipp, University of Southern California. **Mail:** 14340 Dickens, Sherman Oaks, Calif. (**S**)

Quiroga, Alex S., TV Engineer, ABC-TV. **Mail:** 3757½ Monon St., Hollywood, Calif. (**M**)

South, David F. W., University of Southern California. **Mail:** 5353 W. Third St., The Art Center School, Los Angeles, Calif. (**S**)

Swenson, Russell, University of Southern California. **Mail:** 682 W. 35 St., Los Angeles 7, Calif. (**S**)

Ward, Julius C., Electronic Engineer, General Precision Laboratory, 7 Manville La., Pleasantville, N.Y. (**A**)

Wheeler, Charles F., Assistant Cameraman, Free-lance. **Mail:** 2557 Westwood Blvd., Los Angeles 64, Calif. (**A**)

Wilt, Chester, Development Engineer, Eastman Kodak Co. **Mail:** 4007 St. Paul Blvd., Rochester 17, N.Y. (**A**)

Win, Maung Nay, University of Southern California. **Mail:** 1130 W. 37 St., Los Angeles, Calif. (**S**)

Wong, Willie, SRT—TV Studios. **Mail:** 66 Cedar Dr., Farmingdale, N.Y. (**S**)

CHANGES IN GRADE

Bauman, Harold W., (**A**) to (**M**)
Demetros, Nicholas K., (**A**) to (**M**)
Duvall, Delmer P., (**A**) to (**M**)
Gemeinhardt, George C., (**A**) to (**M**)
Gillet, Albert, (**A**) to (**M**)
Helhena, Leslie E., (**A**) to (**M**)
Kemp, Jay S., (**A**) to (**M**)
Krulish, John A., (**A**) to (**M**)
Manley, Fred A., (**A**) to (**M**)
McGough, William A., (**A**) to (**M**)
Newmayer, Richard H., (**A**) to (**M**)
Pittaro, Ernest M., (**A**) to (**M**)
Schwarz, Sigmund, (**A**) to (**M**)
Searle, Milton H., (**A**) to (**M**)
Smith, H. Beresford, (**A**) to (**M**)
Sparks, R. F., (**A**) to (**M**)
Szeglin, Stephen J., (**A**) to (**M**)
Wesson, Rufus, (**A**) to (**M**)

Meetings

The Atlantic Coast Section of the SMPTE will meet on April 16, 7:30 P.M., at the Henry Hudson Hotel, New York City, when Robert Dressler of Paramount Pictures Corp.'s Chromatic Television Laboratories will present a paper and a demonstration on electrooptic sound recording on film.

71st Semiannual Convention of the SMPTE, April 21–25, The Drake, Chicago

Other Societies

American Physical Society, May 1–3, Washington, D.C.

Acoustical Society of America, May 8–10, New York

Society of Photographic Engineers, Symposium on Instrumentation, June 4–5, Naval Ordnance Laboratory, White Oak, Md.

American Institute of Electrical Engineers, Summer General Meeting, June 23–27, Hotel Nicollet, Minneapolis, Minn.

American Physical Society, June 30–July 3, Denver, Colo.

National Audio-Visual Association, Convention and Trade Show, Aug. 2–5, Hotel Sherman, Chicago

Photographic Society of America, Annual Convention, Aug. 12–16, Hotel New Yorker, New York

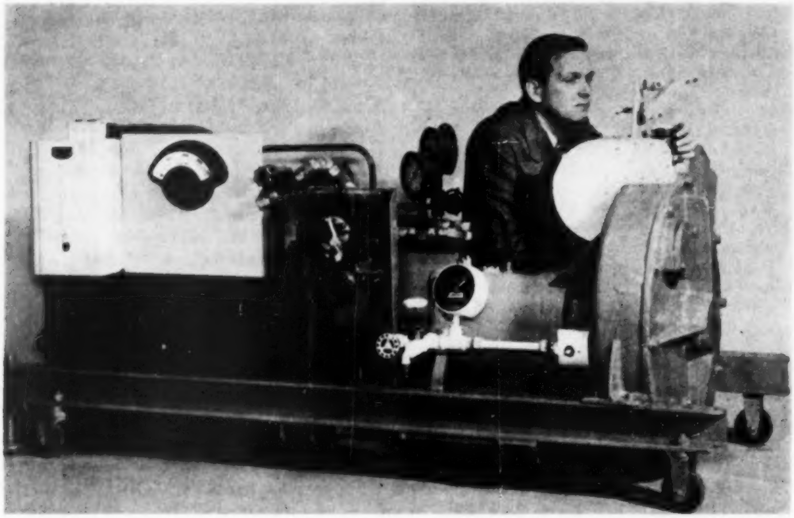
American Institute of Electrical Engineers, Pacific General Meeting, Aug. 19–22, Hotel Westward Ho, Phoenix, Ariz.

Illuminating Engineering Society, National Technical Conference, Aug. 27–30, Washington, D.C.

International Society of Photogrammetry, Conference, Sept. 4–13, Hotel Shoreham, Washington, D.C.

New Products

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products.



A new ultra-high-speed camera, designed to take pictures at speeds up to 100,000 frames/sec, has been developed at Battelle Institute, Columbus, Ohio. It will be described by C. D. Miller of the Battelle technical staff in a paper to be presented before an early convention of SMPTE. The camera is an extensively modified version of one developed by Mr. Miller some years ago while employed by the National Advisory Committee for Aeronautics. The earlier camera was described in the November 1949 *Journal* and in the reprint, *High-Speed Photography*, Vol. 2.

The new camera is being used at Battelle in studies of knock in spark-ignited piston engines, and will be available for other high-speed research at Battelle as desired by industry or government. The camera operates under conditions of steady light, with direct photography, Schlieren photography or shadowgraphs. It operates by optical compensation, exposes six feet of standard 8-mm film in a single burst, with resolution reported better than 30 lines per millimeter. Exposed film is ready for projection as a motion picture immediately after development, without the need of a reprinting and registering procedure.

Back issues of the Journal available: The following Volumes are available upon a reasonable offer to Alfred S. Norbury, 3526 Harrison St., Kansas City 3, Mo.

Vol. 44 (Jan.-June 1945)
Vol. 45 (July-Dec. 1945)
Vol. 47 (July-Dec. 1946)
Vol. 48 (Jan.-June 1947)
Vol. 49 (July-Dec. 1947)
Vol. 50 (Jan.-June 1948)
Vol. 51 (July-Dec. 1948)
Vol. 52 (Jan.-June 1949)
Vol. 56 (Jan.-June 1951)
Vol. 57 (July-Dec. 1951)

A Silent Magnetic Splicer has been developed and patented by Unusual Films at Bob Jones University in Greenville, S.C., which says that it is for the fast and durable splicing of magnetic film. A diagonal butt splice with Minnesota Mining and Manufacturing Tape No. 41 that will outlast normal film has been achieved. A single frame can be removed and restored; a splice made in this manner can be broken and put together again without loss of a frame; and trims and waste material can be reclaimed and used repeatedly until too short to be of any value. Designed specifically for magnetic film in accordance with existing film standards, the Silent Splicer needs no blooping. While there is some disadvantage, the University says, in not being able to see the striations, with a little practice and familiarization with a sound reader one can locate sync closer than half a frame. Film must be handled carefully and all heads must be demagnetized regularly, if clear sound is to be maintained.

The Sound Splicer is designed so that one side of the machine is for cutting of film, the other side for registration, perforation and application of the tape. It is available for 16mm film either double or single perforated.

"**Common Causes of Damage to 35mm Release Prints**" has just been issued in an extensively revised edition by the Eastman Kodak Company as a means of helping laboratories, exchanges, and theaters to keep motion picture release prints in better condition.

The booklet discusses such possible sources of damage as failure to provide adequate storage facilities, improper laboratory methods, inadequate inspection in the exchanges, careless handling in the projection room and worn or imperfectly adjusted projectors. Also covered are such general but equally important subjects as making good splices, methods of lubrication of release prints, directions for determining the correct tension of projector parts, and methods of making other simple projector adjustments.

Some of the material that appears in this new data book has been issued by Kodak in previous booklets covering the same general field, but all of the old material has now been brought up to date and a discussion of how properly to identify the new safety base material now used for release prints has also been added.

Written in four sections—the film, the processing laboratory, the exchange and the theater—and liberally illustrated with many comparison photographs, "Common Causes of Damage to 35mm Release Prints" can be obtained without charge on request to the Motion Picture Division, Eastman Kodak Company. The data book is punched for binding in the *Kodak Photographic Notebook*.

Position Wanted

Sound mixer and transmission engineer: 5 yr experience 35mm magnetic and optical, 16mm optical and disc recording systems. As mixer has experience stage recording and re-recording; in transmission has installed a recording channel complete from design to operation, also maintenance. Will accept position any geographic location. Write L-30, c/o Fifer, 143 Church St., Phoenixville, Pa.

Committees of the Society

As of March 15, 1952

Administrative Committees

ADMISSIONS. *To pass upon all applications for membership, applications for transfer, and to review the Student and Associate membership list periodically for possible transfer to the Associate and Active grades, respectively. The duties of each committee are limited to applications and transfers originating in the geographic area covered.*

E. A. Bertram, *Chairman, East,* DeLuxe Laboratories, 850 Tenth Ave., New York 19, N.Y.

C. R. Keith W. B. Lodge L. A. Bonn

Bertel J. Kleerup, *Chairman, Central,* Society for Visual Education, 1345 W. Diversey Parkway, Chicago 14, Ill.

E. E. Bickel Lloyd Thompson M. G. Townsley

N. L. Simmons, *Chairman, West,* Eastman Kodak Co., 6706 Santa Monica Blvd., Hollywood 38, Calif.

T. T. Moulton E. H. Reichard Petro Vlahos

BOARD OF EDITORS. *To pass upon the suitability of all material submitted for publication, or for presentation at conventions, and publish the* JOURNAL.

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EUROPEAN ADVISORY COMMITTEES. *To act as liaison between the general Society and European firms, individuals, and organizations interested in motion picture and television engineering. To report to the Society on such affairs in Europe, on new technical developments, and to assist the Papers Committee in soliciting papers for publication in the* JOURNAL.

I. D. Wratten, *Chairman (British Division),* Kodak, Ltd., Kingsway, London, England

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M. Certes
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J. Fourrage
G. Mareschal
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J. Vivié
M. Yvonnet

FELLOW AWARD. *To consider publications of Active members as candidates for elevation to Fellow, and to submit such nominations to the Board of Governors.*

Earl I. Sponable, *Chairman,* Movietonews, Inc., 460 W. 54 St., New York 19, N. Y.

Herbert Barnett
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F. E. Cahill
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J. G. Frayne
C. E. Heppberger
Barton Kreuzer
W. C. Kunzmann
Peter Mole
V. C. Shaner
E. M. Stifle

HISTORICAL AND MUSEUM. *To collect facts and assemble data relating to the historical development of the motion picture and television industries, to encourage pioneers to place their work on record in the form of papers for publication in the* JOURNAL, *and to place in suitable depositories equipment pertaining to the industry.*

E. A. Bertram, *Chairman*, DeLuxe Laboratories, Inc., 850 Tenth Ave., New York 19, N.Y.

(Under Organization)

HONORARY MEMBERSHIP. *To search diligently for candidates who through their basic inventions or outstanding accomplishments have contributed to the advancement of the motion picture industry and are thus worthy of becoming Honorary members of the Society.*

Gordon Chambers, *Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

Carroll H. Dunning	Philo T. Farnsworth	Barton Kreuzer	Loren L. Ryder

JOURNAL AWARD. *To recommend to the Board of Governors the author or authors of the most outstanding paper originally published in the* JOURNAL *during the preceding calendar year to receive the Society's Journal Award.*

F. J. Kolb, Jr., *Chairman*, Eastman Kodak Co., 343 State St., Rochester 4, N.Y.

Paul Arnold	A. N. Goldsmith	Joseph H. Spray

MEMBERSHIP. *To solicit new members and to arouse general interest in the activities of the Society and its publications.*

A. Raymond Gallo, *General Chairman*, Quigley Publications, 1270 Sixth Ave., New York 20, N.Y.

J. B. McCullough, *Vice-Chairman*, Motion Picture Association, 28 W. 44th St., New York 18, N.Y.

Col. Samuel R. Todd, *Vice-Chairman*, Bureau of Electrical Inspection, Room 707, City Hall, Chicago 2, Ill.

L. D. Grignon, *Vice-Chairman*, Twentieth Century-Fox, Box 900, Beverly Hills, Calif.

Don Prideaux, Lamp Department, General Electric Company, 601 W. Fifth St., Los Angeles 13, Calif.

John W. Duvall, E. I. du Pont de Nemours & Co., 6656 Santa Monica Blvd., Hollywood 38, Calif.

H. S. Walker, *Chairman*, 4040 St. Catherine St., W., Montreal, Quebec.

(Under Organization)

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A. R. Davis	Hugh Jamieson	J. W. Servies	

NOMINATIONS. *To recommend nominations to the Board of Governors for annual election of officers and governors.*

Earl I. Sponable, *Chairman*, Movietonews, Inc., 460 W. 54 St., New York 19

F. T. Bowditch	N. D. Golden	J. K. Hilliard	C. H. Percy
G. L. Carrington	D. E. Hyndman	F. E. Cahill	R. C. Warn

PAPERS. *To solicit papers and provide the program for semiannual conventions, and make available to local sections for their meetings papers presented at national conventions.*

Edward S. Seeley, *Chairman*, Altec Service, 161 Sixth Ave., New York 13, N.Y.

Joseph E. Aiken, *Vice-Chairman*, 116 No. Galveston St., Arlington, Va.

F. G. Albin, *Vice-Chairman*, American Broadcasting Co., Station KECA-TV, 4151 Prospect Ave., Hollywood, Calif.

G. G. Graham, *Vice-Chairman*, National Film Board of Canada, John St., Ottawa, Canada

W. H. Rivers, *Vice-Chairman*, Eastman Kodak Co., 342 Madison Ave., New York 17, N.Y.

G. W. Colburn, *Vice-Chairman*, 164 N. Wacker Dr., Chicago 6, Ill.

John H. Waddell, *Vice-Chairman*, Wollensak Optical Co., 850 Hudson Ave., Rochester, N.Y.

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Richard Blount	Farciot Edouart	William Kelley	Edward Schmidt
R. P. Burns	F. L. Eich	George Lewin	N. L. Simmons
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F. O. Calvin	R. N. Harmon	Glenn Matthews	J. G. Stott
J. P. Corcoran	Scott Helt	Pierre Mertz	W. L. Tesch
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PROGRESS. *To prepare an annual report on progress in the motion picture and television industries.*

C. W. Handley, *Chairman*, 1960 West 84 St., Los Angeles 44, Calif.

J. E. Aiken	T. J. Gibbons	W. F. Kelley	B. F. Perry
W. L. Bell	G. H. Gordon	R. E. Lewis	E. H. Reichard
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PROGRESS MEDAL AWARD. *To recommend to the Board of Governors a candidate who by his inventions, research, or development has contributed in a significant manner to the advancement of motion picture technology, and is deemed worthy of receiving the Progress Medal Award of the Society.*

David B. Joy, *Chairman*, National Carbon Division, 30 E. 42 St., New York 17, N.Y.

Max Batsel	F. H. McIntosh	G. H. Mitchell	D. R. White

DAVID SARNOFF AWARD. *To recommend to the Board of Governors a candidate who has done outstanding work in some technical phase of the broad field of television or in any similar phase of theater television, whether in research, development design, manufacture or operation.*

Pierre Mertz, *Chairman*, Bell Telephone Laboratories, Inc., 463 West, St. New York 14, N.Y.

R. L. Garman	T. T. Goldsmith	O. B. Hanson	W. B. Lodge

SUSTAINING MEMBERSHIP. *To solicit new sustaining members and thereby obtain adequate financial support required by the Society to carry on its technical and engineering activities.*

Earl I. Sponable, *Chairman*, Movietonews, Inc., 460 W. 54 St., New York 19, N.Y.

D. B. Joy	S. P. Solow

SAMUEL L. WARNER AWARD. *To recommend to the Board of Governors a candidate who has done the most outstanding work in the field of sound motion picture engineering, in the development of new and improved methods or apparatus designed for sound motion pictures, including any steps in the process, and who, whether or not a Member of the Society of Motion Picture and Television Engineers, is deemed eligible to receive the Samuel L. Warner Memorial Award of the Society*

Glenn L. Dimmick, *Chairman*, RCA Victor Division, Front and Cooper Sts., Camden, N.J.

Lloyd Goldsmith	John Hilliard	John Maurer	Otto Sandvik

Engineering Committees

COLOR. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of color motion picture processes, accessory equipment, studio lighting, selection of studio set colors, color cameras, color motion picture films, and general color photography. (File C 1)*

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R. O. Drew	L. T. Goldsmith	C. F. J. Overhage	J. P. Weiss

FILM DIMENSIONS. *To make recommendations and prepare specifications on those film dimensions which affect performance and interchangeability, and to investigate new methods of cutting and perforating motion picture film in addition to the study of its physical properties. (File FD 2)*

E. K. Carver, *Chairman*, Eastman Kodak Co., Kodak Park Works, Rochester 4, N.Y.

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A. M. Gundelfinger	W. E. Pohl		

FILM-PROJECTION PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture projection equipment, projection rooms, film-storage facilities, stage arrangement, screen dimensions and placement, and maintenance of loudspeakers to improve the quality of reproduced sound and the quality of the projected picture in the theater. (File FPP 3)*

R. H. Heacock, *Chairman*, Radio Corporation of America, RCA Victor Div., Camden 2, N.J.

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L. W. Davee	H. T. Matthews	Harry Rubin	S. R. Todd

FILMS FOR TELEVISION. *To make recommendations and prepare specifications on all phases of the production, processing and use of film made for transmission over a television system excluding video transcriptions. (File FTV 4)*

R. L. Garman, *Chairman*, General Precision Laboratory, Inc., 63 Bedford Road, Pleasantville, N.Y.

R. O. Drew	Pierre Mertz	R. C. Rheineck	C. L. Townsend
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S. E. Howse	G. C. Misener	N. L. Simmons	T. G. Veal
R. Johnston	R. M. Morris	J. G. Stott	H. E. White
H. R. Lipman			

HIGH-SPEED PHOTOGRAPHY. *To make recommendations and prepare specifications for the construction, installation, operation, and servicing of equipment for photographing and projecting pictures taken at high repetition rates or with extremely short exposure times. (File HSP 5)*

H. E. Edgerton, *Chairman*, Dept. of Electrical Engineering, Massachusetts Institute of Technology, Cambridge 39, Mass.

Richard O. Painter, *Vice-Chairman*, General Motors, Proving Ground Section, Milford, Mich.

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H. C. Barr	Eleanor Gerlach	D. H. Peterson	J. H. Waddell
D. M. Beard	C. D. Miller	Earl Quinn	Roy Wolford
C. S. Braser	Eugene Miller	M. L. Sandell	C. W. Wyckoff
F. E. Carlson	Kenneth Morgan	Kenneth Shaftan	

LABORATORY PRACTICE. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture printers, processing machines, inspection projectors, splicing machines, film-cleaning and treating equipment, rewinding equipment, any type of film-handling accessories, methods, and processes which offer increased efficiency and improvements in the photographic quality of the final print. (File LP 6)*

J. G. Stott, *Chairman*, Du Art Film Laboratories, 245 West 55 St., New York, N.Y.

V. D. Armstrong	G. W. Colburn	J. A. Maurer	V. C. Shaner
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Gordon Chambers	C. F. LoBalbo	E. H. Reichard	

MOTION PICTURE STUDIO LIGHTING AND PROCESS PHOTOGRAPHY. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of all types of studio and outdoor auxiliary lighting equipment, tungsten light and carbon-arc sources, lighting-effect devices, diffusers, special light screens, etc., to increase the general engineering knowledge of the art; and to make recommendations and prepare specifications on motion picture optical printers, process projectors (background process), matte processes, special process lighting technique, special processing machines, miniature-set requirements, special-effects devices, and the like, that will lead to improvement in this phase of the production art. (File MPSL 7)*

J. W. Boyle, *Chairman*, 139½ South Doheny Dr., Los Angeles 48, Calif.

Richard Blount	C. W. Handley	C. R. Long	D. W. Prideaux
Karl Freund	M. A. Hankins	W. W. Lozier	Petro Vlahos

OPTICS. *To make recommendations and prepare specifications on all subjects connected with lenses and their properties. (File Op 8)*

R. Kingslake, *Chairman*, Eastman Kodak Co., Hawk Eye Works, Rochester 4, N.Y.

F. G. Back	J. W. Gillon	G. A. Mitchell	L. T. Sachtleben
A. A. Cook	Grover Laube	A. E. Murray	O. H. Schade
C. R. Daily	J. L. Maulbetsch	W. E. Pohl	M. G. Townsley
I. C. Gardner	J. A. Maurer		

SCREEN BRIGHTNESS. *To make recommendations, prepare specifications, and test methods for determining and standardizing the brightness of the motion picture screen image at various parts of the screen, and for special means or devices in the projection room adapted to the control or improvement of screen brightness. (File SB 10)*

W. W. Lozier, *Chairman*, National Carbon Div., Fostoria, Ohio

H. J. Benham	A. J. Hatch	O. W. Richards	G. H. Walter
F. E. Carlson	L. B. Isaac	Leonard Satz	H. E. White
M. H. Chamberlin	W. F. Kelley	Ben Schlanger	A. T. Williams
E. R. Geib	F. J. Kolb	Allen Stimson	D. L. Williams
L. D. Grignon	L. J. Patton	C. R. Underhill	

16MM AND 8MM MOTION PICTURES. *To make recommendations and prepare specifications for 16mm and 8mm cameras, 16mm sound recorders and sound-recording practices, 16mm and 8mm printers and other film laboratory equipment and practices, 16mm and 8mm projectors, splicing machines, screen dimensions and placement, loudspeaker output and placement, preview or theater arrangements, test films, and the like, which will improve the quality of 16mm and 8mm motion pictures. (File SE 11)*

M. G. Townsley, *Chairman*, Bell & Howell Co., 7100 McCormick Rd., Chicago 45, Ill.

H. W. Bauman	E. W. D'Arcy	H. J. Hood	A. G. Petrasek
W. C. Bowen	G. A. del Valle	W. W. Lozier	L. T. Sachtleben
F. L. Brethauer	J. W. Evans	D. F. Lyman	H. H. Strong
F. E. Brooker	C. R. Fordyce	W. C. Miller	Lloyd Thompson
F. E. Carlson	John Forrest	J. W. Moore	Willett Wilson
Carl Claras	R. C. Holslag	W. H. Offenhauser	

SOUND. *To make recommendations and prepare specifications for the operation, maintenance, and servicing of motion picture film, sound recorders, re-recorders, and reproducing equipment, methods of recording sound, sound-film processing, and the like, to obtain means of standardizing procedures that will result in the production of better uniform quality sound in the theater.* (*File So 12*)

J. K. Hilliard, *Chairman*, Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif.

G. L. Dimmick, *Vice-Chairman*, RCA Victor Division, Camden, N.J.

F. G. Albin	E. W. D'Arcy	J. P. Livadary	G. E. Sawyer
H. W. Bauman	R. J. Engler	J. A. Maurer	W. L. Thayer
R. J. Beaudry	R. M. Fraser	K. M. MacIlvain	M. G. Townsley
A. C. Blaney	J. G. Frayne	W. C. Miller	Harold Walker
D. J. Bloomberg	L. T. Goldsmith	G. C. Misener	J. P. Weiss
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